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Sampling and Analysis of Selected Toxic Substances Task IV-Ethylene Dibromide

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SAMPLING AND ANALYSIS OF SELECTED TOXIC SUBSTANCES

Task IV - Ethylene Dibromide

Environmental Protection Agency
Office of Toxic Substances
Washington, D.C. 20460

July 1976

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Sites representing six categories of potential sources of EDB emission were sampled. The categories are: (1) gasoline mixing, storage, and transfer (refineries); (2) retail gasoline; (3) highly trafficked urban; (4) suburban residential (lightly trafficked); (5) rural; and (6) fumigation centers.

Air samples collected near four different bulk loading stations had EDB levels at least twice that of background samples. These levels ranged from 0.13 to 0.20 $\mu g/m^3$ of EDB. The elevated levels were not discernible beyond 1/8 mile from the stations. The EDB concentration in air near pipeline pumping stations, lead mix blending facilities, and lead mix storage areas was not elevated above background. Air samples collected near clusters of gasoline stations in two cities had EDB concentrations ranging from 0.18 to 0.50 $\mu g/m^3$, which was 2 to 2.5 times greater than sampling sites 1/8 to 1 mile away. The third city had background levels ranging from 0.38 to 0.49 $\mu g/m^3$, and the effect of the gasoline stations was not discernible. The effect of heavily trafficked freeways on the EDB levels in two different cities was not discernible. However, EDB was detected in all samples taken in heavily trafficked urban areas. The ubiquitous nature of EDB is probably the result of the widely dispersed sources of emission in

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urban/industrial areas. The levels of EDB in air ranged from 0.05 to 0.10 µg/m^3 in rural and suburban areas, and from 0.1 to 0.4 µg/m^3 in metropolitan areas.

Two fumigation centers where EDB was used to fumigate grapefruit were found to be significant sources of emission. The highest downwind ambient air level was 96 µg/m^3. The highest levels were observed when EDB was being exhausted from the fumigation chambers. However, levels higher than background were observed before the chambers had been purged. Levels inside the facility were 40 to 70 times greater than the highest ambient air levels; the highest level observed, 6,930 µg/m^3, was found using a personnel sampler placed on an employee. The average level of exposure inside the fumigation centers ranged from 370 to 3,100 µg/m^3.

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SAMPLING AND ANALYSIS OF SELECTED TOXIC SUBSTANCES

Task IV - Ethylene Dibromide

Contract No. 68-01-2646

Project Officer

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SUMMARY

The purpose of this program was to provide sampling and analysis capabilities to EPA's Office of Toxic Substances, so that the levels of suspected toxic substances in air, water, soil, and sediment at designated locations throughout the United States could be determined. Four tasks were assigned on this program. The final task was the sampling and analysis for ethylene dibromide (EDB).

Methods for sampling and analyzing EDB in air, water, soil, and sediments were evaluated. A protocol was developed and approved.

Sampling sites were selected from six potential source categories. These categories are: (a) gasoline mixing, storage and transfer (refineries); (b) retail gasoline; (c) highly trafficked urban; (d) suburban residential (lightly trafficked); (e) rural, and (f) fumigation centers.

Air samples collected near four different bulk loading stations had EDB levels at least twice that of background samples. These levels ranged from 0.13 to 0.20 $\mu g/m^3$ of EDB. The elevated levels were not discernible beyond 1/8 mile from the stations. The EDB concentration in air near pipeline pumping stations, lead mix blending facilities, and lead mix storage areas was not elevated above background.

Air samples collected near clusters of gasoline stations in two cities had EDB concentrations ranging from 0.18 to 0.50 $\mu g/m^3$, which was 2 to 2.5 times greater than sampling sites 1/8 to 1 mile away. The third city had background levels ranging from 0.38 to 0.49 $\mu g/m^3$, and the effect of the gasoline stations was not discernible.

The effect of heavily trafficked freeways on the EDB levels in two different cities was not discernible. However, EDB was detected in all samples taken in heavily trafficked urban areas. The ubiquitous nature of EDB is probably the result of the widely dispersed sources of emission in urban/industrial areas. The levels of EDB in air ranged from 0.05 to 0.10 $\mu g/m^3$ in rural and suburban areas, and from 0.1 to 0.4 $\mu g/m^3$ in metropolitan areas.

Two fumigation centers where EDB was used to fumigate grapefruit were found to be significant sources of emission. The highest downwind ambient air level was 96 $\mu g/m^3$. The highest levels were observed when EDB was being exhausted from the fumigation chambers. However, levels higher than background were observed before the chambers had been purged. Levels inside the facility were 40 to 70 times greater than the highest ambient air levels; the highest level observed, 6,930 $\mu g/m^3$, was found using a personnel sampler placed on an employee. The average level of exposure inside the fumigation centers ranged from 370 to 3,100 $\mu g/m^3$.

EDB was detected in soil near the fumigation center in the low nanogram per gram range. EDB dustfall rates of 6 to 363 $pg/cm^2/hr$ were observed in the vicinity of the fumigation facilities.

Aqueous effluent from an oil refinery and rainfall runoff near several gasoline stations contained less than 0.2 μg/liter EDB. Rainfall collected near a fumigation center contained 1 μg/liter EDB; runoff water from the same location contained 2 μg/liter.

SECTION I

INTRODUCTION

In mid-1975, Midwest Research Institute (MRI) conducted a limited and preliminary study of the presence of ethylene dibromide (EDB) in ambient air and surface water. The air monitoring data showed air concentration values of 0.07 to 0.11 $\mu g/m^3$ (about 0.01 ppb) in the vicinity of gasoline stations along traffic arteries in three cities (Phoenix, Los Angeles, and Seattle), 0.2 to 1.7 $\mu g/m^3$ (about 0.1 ppb) on the property of an oil refinery in Kansas City, and 90 to 115 $\mu g/m^3$ (10 to 15 ppb) at EDB manufacturing sites in Arkansas. Concentrations on the order of 1 ppb of EDB were found in two samples from streams of water on industrial sites.[1/]

This preliminary study was part of an MRI project (3953-C) entitled "Sampling and Analysis of Selected Toxic Substances" which was initiated on June 27, 1974. The objective of this program was to provide the EPA with sampling and analysis capabilities to determine the levels of toxic substances in air, water, soil and sediment from designated sources and ambient locations throughout the United States. The first task of this program was the sampling and analysis for HCB and HCBD. Final reports for this task were reported to the Office of Toxic Substances in June 1976 under the titles "Sampling and Analysis of Selected Toxic Substances: Task IA - Hexachlorobenzene" and "Sampling and Analysis of Selected Toxic Substances: Task IB - Hexachlorobutadiene."

Tasks II and III of this program were the sampling and analysis for ethylene dibromide and the evaluation of vinyl chloride levels in outdoor and indoor air due to the presence of PVC products. The task II ethylene dibromide study has been completed and reported to the Office of Toxic Substances in September 1975 under the title of "Sampling and Analysis of Selected Toxic Substances: Task II - Ethylene Dibromide," EPA Report No. 560/6-75-001. The Task III study has been completed and reported to the Office of Toxic Substances in April 1975 under the title "Sampling and Analysis of Selected Toxic Substances: Task III - Vinyl Chloride, Secondary Sources," EPA Report No. 560/6-76-002.

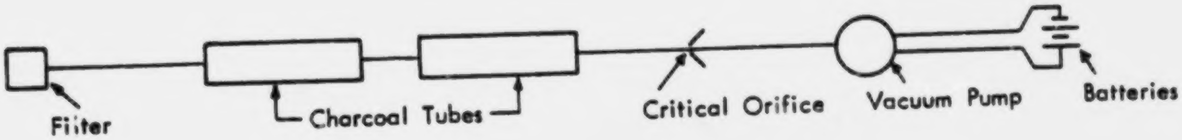
This report describes Task IV of the program, i.e., the sampling and analysis of EDB as follows: Section II, Experimental Procedures; Section III, Selection of Sampling Sites; Section IV, Presampling Site Visits and Field Sampling; Section V, Discussion of Results, and Section VI, Summary and Conclusions. Site visits and field sampling data for individual sites, analytical data and methods development efforts are appended to the report.

SECTION II

EXPERIMENTAL PROCEDURES

SAMPLING PROCEDURES

Air was sampled through a 37 mm diameter, 0.8 µm pore size, Millipore filter, followed by two 16 cm, 6.0 mm I.D. glass sampling tubes, arranged in series and packed with 2 g of 6 to 14 mesh charcoal. Air was drawn through the sampling train by means of a battery powered mechanical pump. The flow rate was regulated by either an 18 or 20 gauge hypodermic needle. A schematic of the train is shown below. After sampling, the tubes and the filters were carefully packed and stored over dry ice until delivery at MRI. Blanks were taken to the field and analyzed as normal samples.



Grab water samples were collected whenever an opportunity occured. The samples were collected in brown glass bottles of 1 qt capacity that had been previously cleaned with pesticide grade solvents. The bottles were capped using Teflon® liners and stored in an ice chest until returned to MRI.

Soil samples were taken from the top 1 in. around selected air sampling stations. The samples were placed in cleaned 16 oz bottles and stored in an ice chest until returned to MRI.

Dustfall was collected at selected air sampling stations in glass bottles having a mouth diameter of 8.0 cm. Approximately 200 ml of distilled water was placed in the dustfall containers. At the end of the sampling period, the bottles were sealed with aluminum foil lined caps and stored in an ice chest until returned to MRI.

All samples were kept in a 4° C cold room at MRI until analyzed.

ANALYSIS PROCEDURES

Sample Preparation

From each air sample, the Millipore filter, and the two charcoal traps were extracted separately with 10, 10 and 5 ml of pesticide grade benzene (Burdick and Jackson). The samples were manually shaken periodically allowing a total of 45 min for each extraction. The extracts were collected in a 25 ml volumetric flask which was then diluted to volume.

An aliquot of each water sample was extracted twice with pesticide grade hexane at a V_{aq}/V_{hexane} ratio of 20. The hexane extracts were combined in a volumetric flask and diluted to volume.

The soil samples were analyzed without drying to avoid loss of EDB by volatilization. The samples were sifted on a U.S. Standard No. 18 sieve to remove stones and other foreign material. Thirty grams of the soil was then extracted with 50 ml hexane for 4 hr. The hexane extract was decanted and analyzed.

The water from the dustfall bottles was transferred to a separatory funnel and the bottle rinsed with hexane. The hexane rinsing was added to the separatory funnel and the water was extracted twice with 10.0 ml hexane. The extracts were combined and diluted to 25.0 ml.

Instrumentation and Conditions

A Varian 2440 gas chromatograph equipped with a scandium tritide electron capture detector was used for analysis. The columns used for separation were (a) 10 ft x 1/8 in. stainless steel packed with 5% didecyl phthalate on 80/100 mesh on Chromosorb W, AW, DMCS, (b) 8 ft x 1/8 in. stainless steel packed with 5% Carbowax 20-M-TPA on 80/90 mesh Anakrom ABS, and (c) 12 ft x 1/8 in. stainless steel packed with 3% OV-225 on 100/120 mesh Supelcoport.

All samples that gave a peak matching the retention time of EDB on Column a were then analyzed on Columns b and c. Results were reported only when retention times matched on all three columns. The samples were frequently fortified with EDB for further confirmation.

The conditions were as follows: Column a: injector temperature, 210° C; column temperature, 100° C; detector temperature, 250° C; carrier flow rate 28 ml/min; Column b: injector temperature, 210° C; column temperature, 110° C; detector temperature, 250° C; carrier flow rate, 32 ml/min; Column c: injector temperature, 180° C; column temperature, 85° C; detector temperature, 250° C; carrier flow rate, 25 ml/min.

The instrumental limit of detection was approximately 5 pg. Using the adopted protocol, the minimum detectable quantity of EDB in the collected sample was 10 to 15 ng.

Normally a 10 ng/ml standard of EDB in benzene was used to prepare a calibration curve prior to analysis. During actual sample analysis, a standard was injected after every five samples.

SECTION III

SELECTION OF SAMPLING SITES

The objective of this task was to determine environmental levels of EDB by the sampling and analysis of selected sites. The general intention of the selection of actual sampling sites was to provide results sufficiently detailed to permit:

1. An estimate of the size of the geographical area being influenced by air emissions from each source and a description of the gradation in the intensity of exposure potential within the geographical area.

2. A quantification of the ethylene dibromide entering surface water as a result of direct effluent discharges and fallout of the chemical from the ambient air.

SITE SELECTION CRITERIA

The sites to be sampled for EDB were diverse in nature, ranging from rural to trafficked suburban to industrial. While the site selection criteria are varied, some criteria were universally applied.

The generally applicable criteria were:

* Geographical distribution;

* Meteorological conditions;

* Accessibility of adjacent property; and

* Isolation from other potential sources.

Geographical Distribution

The geographical location of the sites selected for sampling was important so that results from sample analysis can be used to establish whether contamination of EDB in the environment is a nationwide problem.

Meteorological Conditions

Meteorological conditions during the months when sampling was performed were expected to be harsh in the northern regions of the country. Extremely low temperatures, high winds, and heavy rain or snow would adversely affect the quality of the sampling and generally were avoided.

Accessibility of Adjacent Property

The locations of the sampling sites extended as far as 1 mile from the company property line or a defined point (or line) source. It was required that this land be readily accessible to the sampling personnel and pose no danger to the sampling personnel or equipment.

Isolation from Other Potential Sources

While some of the sources of EDB emissions were localized, others were nearly diffuse. In order to establish the geographical effect of a suspect source, it was necessary that no other potential sources be in the immediate vicinity. Oil refineries, for example, tended to appear in clusters; sampling sites were selected to minimize overlapping emission patterns. Similarly, oil refinery sites were selected that were distant from heavily trafficked roadways, manufacturing plants, etc.

The actual sources of EDB were expected to be (a) the manufacturers, (b) the leaded gasoline producers and users, and (c) the fumigation users. More specific sites were selected within the second category that were expected to represent specific sources of emissions.

It has been estimated that over 80% of the 300 million pounds of EDB produced annually is used as a gasoline additive.[2/] The prime industries and/or activities involved in the use of EDB as a fuel additive are:

1. Oil refinery mixing operations--evaporative loss;
2. Oil refinery storage and bulk transfer--evaporative loss;
3. Retail gasoline stations--evaporative loss; and
4. Automobile traffic--evaporative loss and incomplete combustion.

In the selection of specific sampling sites within these source categories, the following criteria were applied.

Gasoline Mixing, Storage and Transfer

Generally, gasoline produced at an oil refinery is mixed at the refinery with the lead mix and then stored. It is ultimately transferred to trucks or pipelines for transportation to retail outlets. It was desirable to separate the two possible operations that may be contributors, i.e., (a) mixing and (b) storage and transfer. The specific site selection criteria were (a) spatial separation of the mixing operation from storage and transfer operations, (b) a crude capacity of approximately 100,000 barrels per calendar day, (c) a major brand gasoline producer, and (d) isolation from other major oil refineries.

Gasoline Retail (Low Traffic)

The specific criteria for site selection were (a) presence of several active retail gasoline outlets and (b) relatively low vehicular traffic density. It was recommended that the cities chosen for the Highly Trafficked Urban category also be used for this sampling. This selection insured that similar weather conditions would exist during the sampling period and permitted comparisons to be made about the relative significance of these two potential sources.

Highly Trafficked Urban

All major cities have numerous heavily trafficked areas and were naturally potential sampling sites. For this study, the heavily trafficked road was considered as a line source of EDB emissions. In order to attain the stated objectives, the following criteria were applied: (a) the site should be reasonably separated from other sources, e.g., a similar heavily trafficked roadway crossing or adjacent to the site area, and (b) a crossing wind direction, in relationship to the roadway, was preferred.

Suburban Residential

The site was lightly traveled and removed from heavily trafficked arteries, oil refineries, or any other major source.

Rural

The rural site was well removed from all potential sources.

USDA Fumigation

The USDA Fumigation Centers were chosen by the project officer. In addition to the general criteria, it was established that a fumigation operation was underway at the time of sampling.

Agricultural Nematocide Usage

The project officer investigated locations at which EDB-containing nematocides were being used.

Recommended Sampling Sites

With the criteria stated previously, the following sites were selected for sampling in this study.

Oil Refineries	
Continental Oil Company	Ponca City, Oklahoma
Mobil Oil Company	Paulsboro, New Jersey
Retail Gasoline Stations	Phoenix, Arizona Los Angeles, California Camden, New Jersey
Automobile Traffic	Phoenix, Arizona Los Angeles, California
Suburban Residential	Kansas City, Missouri
Rural	Maryville, Missouri
USDA Fumigation	Wahneta, Florida Ft. Pierce, Florida

The geographical locations of these sites are shown in Figure 1.

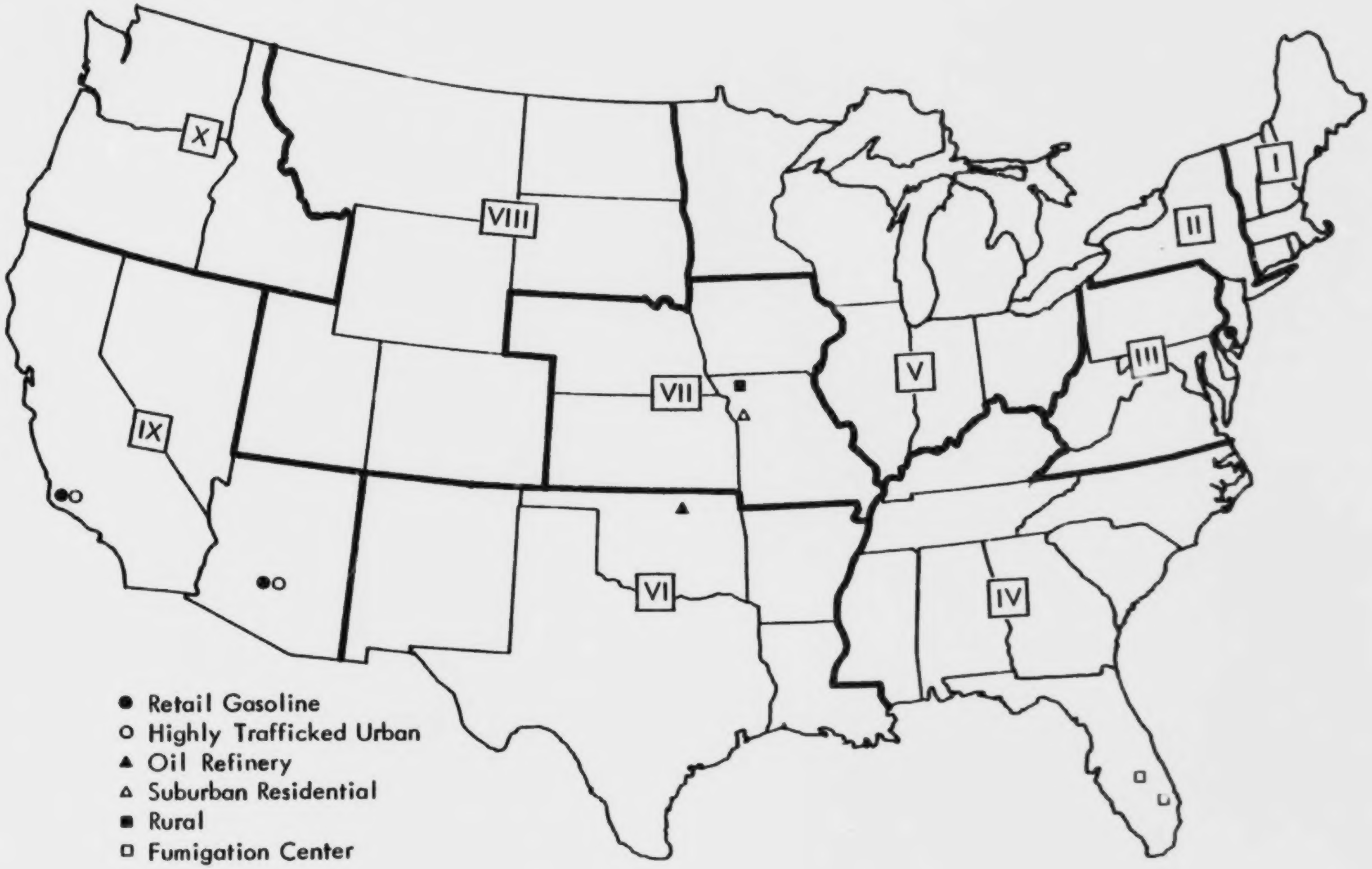

X
VIII
VII
V
II
I
III
IX
VI
IV
● Retail Gasoline
○ Highly Trafficked Urban
▲ Oil Refinery
△ Suburban Residential
■ Rural
□ Fumigation Center

Figure 1. Geographical location of recommended sampling sites.

SECTION IV

PRESAMPLING SITE VISITS AND FIELD SAMPLING

In most cases, a presampling site visit was conducted 1 to 3 weeks prior to the scheduled sampling. Such trips were necessary to select the optimum locations for the sampling stations. When appropriate, a discussion with a plant represententitive was included in the visit. Figure 2 shows the complete schedule for presampling site visits and field sampling.

PRESAMPLING SURVEYS

During the site visit, information about the location and activities of specific potential sources within the plant grounds was requested along with a detailed map of the facility. Meteorological conditions that would affect sampling were also investigated. Provision was made with the appropriate agency to obtain local surface weather observations for the sampling dates. Where appropriate, traffic density data were obtained for areas being sampled.

In instances when sampling equipment was to be placed on public or private property not belonging to the installation being sampled, the property owner and the local law authorities were alerted of our sampling plans and schedules.

FIELD SAMPLING

During the presampling surveys the specific locations of the air sampling stations were determined. The locations were dictated largely by the nature of the source--line, point or diffuse, the wind patterns and the accessibility. Soil and dustfall samples were collected at most of the air sampling stations. Water samples were collected from effluent streams or as storm runoff. The total number of samples analyzed at each site is summarized in Table 1. Detailed descriptions of the presampling site visits and the field sampling at each site are given in Appendix A.

	Jan	Feb	Mar	Apr	May
Phoenix, Arizona: Retail Gas Highly Trafficked Urban		△ ▭			
Los Angeles, Calif.: Retail Gas Highly Trafficked Urban		△	▭		
Maryville, Missouri: Rural			▭		
Kansas City, Missouri: Surburban			▭		
Continental Oil Company Ponca City, Oklahoma			△ ▭		
Mobil Oil Company Paulsboro, New Jersey				△ ▭	
Camden, New Iersey Retail Gas				△ ▭	
State of Florida - USDA Fumigation Center, Wahneta, Florida					△▭
State of Florida - USDA Fumigation Center, Ft. Pierce, Florida					△▭

△ Presampling Site Visit
▭ Field Sampling

Figure 2. Presampling site visit and field sampling schedule.

Table 1. FIELD SAMPLING SUMMARY

Site	Air samples[a/] (stations x train components x sampling periods)	Total samples (number/type)
Conoco	20 x 2 x 1	40 air 6 soil 6 dustfall 2 water
Mobil	13 x 2 x 1	26 air 13 soil 8 dustfall
Retail gas, Phoenix	18 x 2 x 1	36 air
Retail gas, Los Angeles	14 x 2 x 1	28 air
Retail gas, Camden	3 x 2 x 1	6 air
Highly trafficked, Phoenix	10 x 2 x 1	20 air
Highly trafficked, Los Angeles	9 x 2 x 1	18 air
Suburban, Kansas City	1 x 2 x 1	2 air
Rural, Missouri	2 x 2 x 1	4 air
Fumigation Center, Wahneta	17 x 2 x 1 6 x 1 x 3 6 x 1 x 1	58 air 9 soil 9 dustfall
Fumigation Center, Ft. Pierce	17 x 2 x 1 5 x 1 x 4 5 x 1 x 1 1 x 2 x 2	63 air 6 soil 6 dustfall 5 water

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a/ The total number of air samples consists of the number of air sampling stations times the components of the train, i.e., filter and charcoal, times the number of sampling periods.

SECTION V

DISCUSSION OF RESULTS

Air, water, soil and dustfall samples were collected from a variety of locations where emission of ethylene dibromide could occur. In most of the sites, the general sampling strategy was designed to indicate (a) the geographical distribution of EDB, (b) the principal sources of EDB emissions, and (c) the physical form of EDB, i.e., vapor or particulate-bound. The highest levels of EDB were found close to discrete sources such as the fumigation centers, gasoline bulk loading stations and retail gasoline stations, although low levels were still detectable in rural areas. The results for each sampling site are discussed below.

CONTINENTAL OIL COMPANY, OIL REFINERY, PONCA CITY, OKLAHOMA

Field sampling around the Continental Oil Company refinery was conducted on March 31, 1976. The samples collected were: 40 air (20 filters plus 20 charcoal traps), 2 water, 6 soil, and 6 dustfall.

Air Samples

The 40 air samples were collected at 20 sampling stations. Five were located north of the refinery, four were to the south, five were east, four were west, and two were in the middle of the refinery area. The latter two were positioned off State Highway 60, which passed through the refinery, and were in close proximity to the truck bulk loading station and the pipeline pumping station. The nearly symmetrical distribution of sampling stations provided assurance that the geographic distribution of EDB would be measured regardless of the wind patterns during the sampling period. All stations were operated continuously for 18 hr. During this period the wind patterns were varied, as shown by the wind rose shown in Figure 3.

Geographical Distribution: The analytical data for the air samples are given in Table B-1. Figure 4 shows the 18-hr average concentrations of EDB

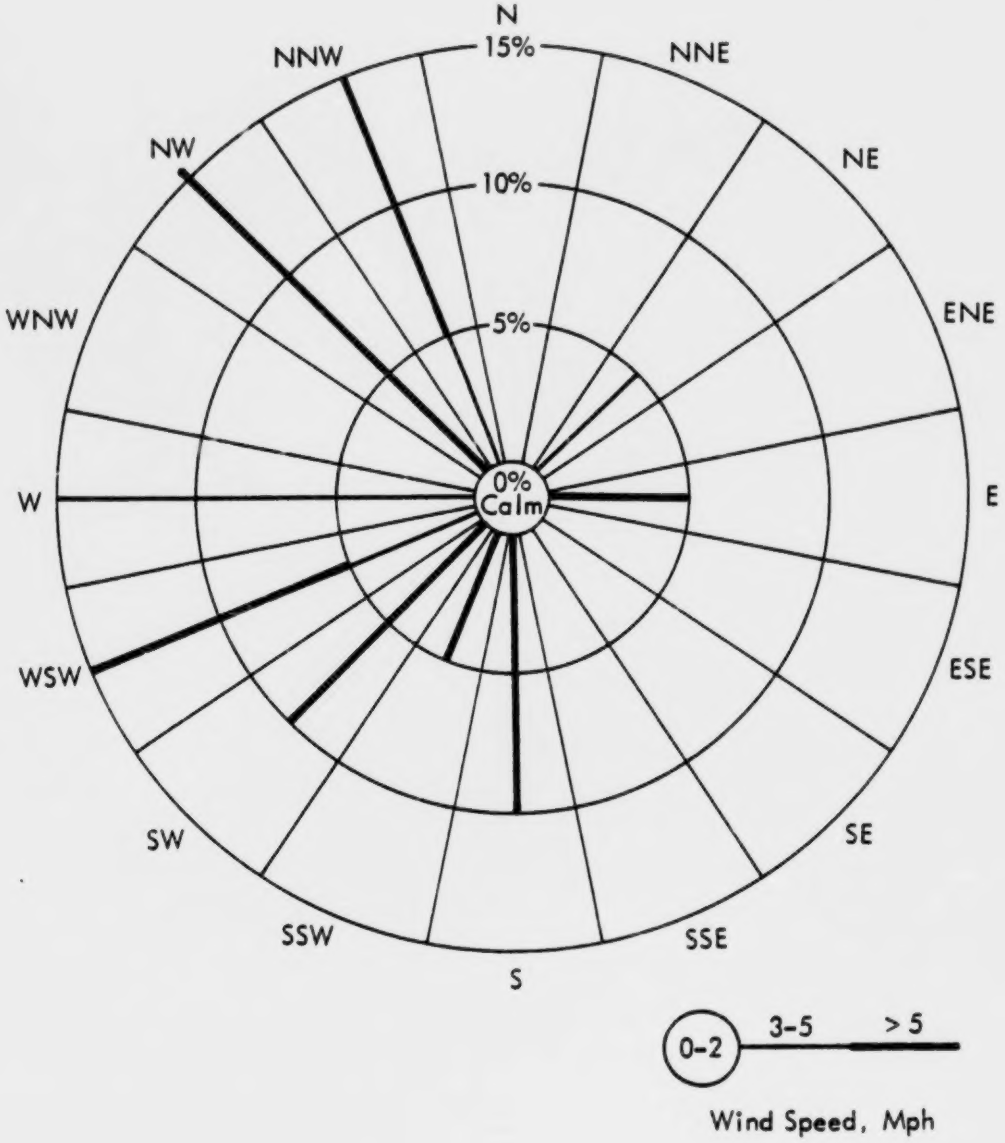


Figure 3. Wind patterns during sampling at Conoco Oil Refinery, Ponca City, Oklahoma.

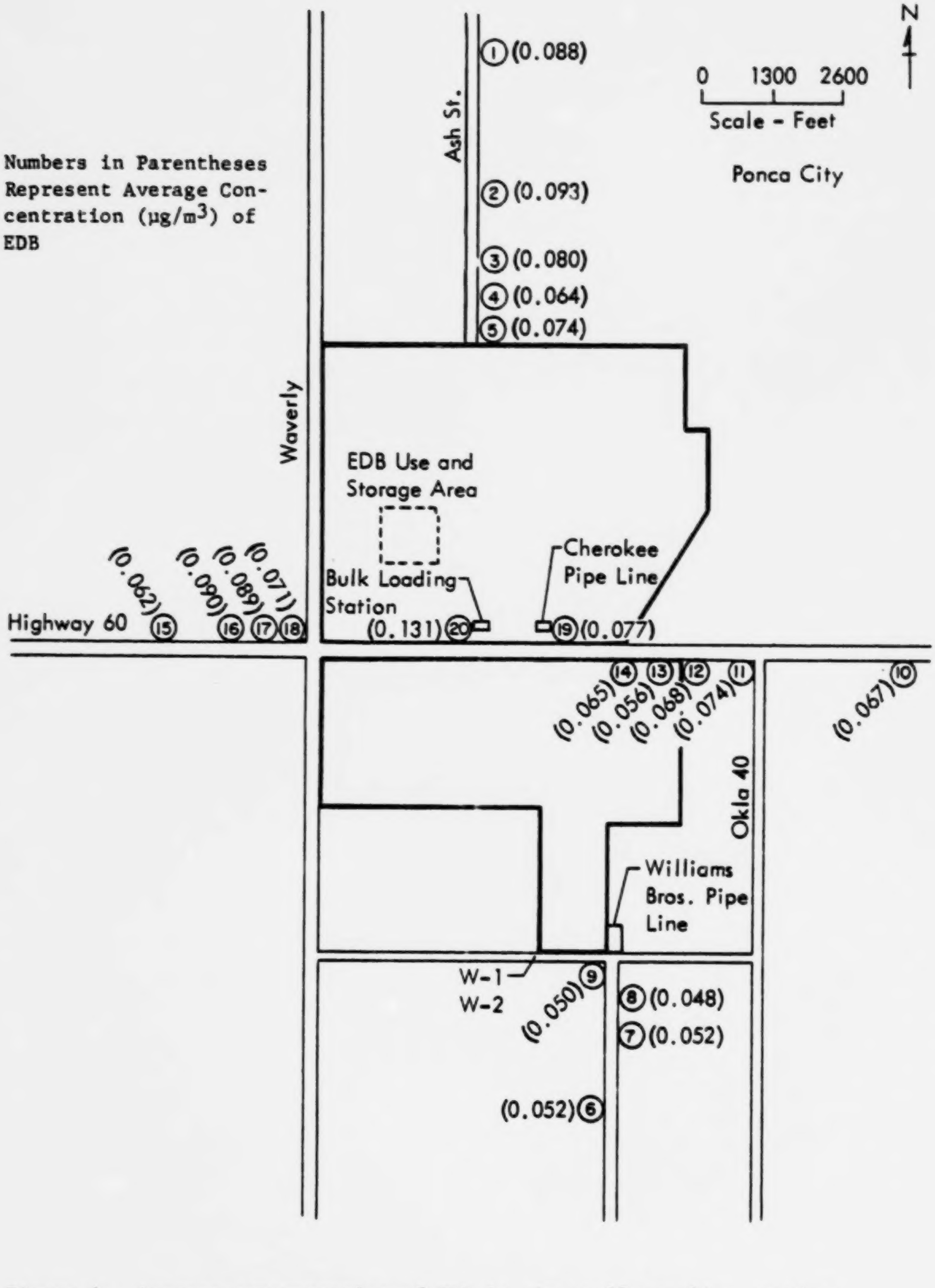

Numbers in Parentheses Represent Average Concentration (µg/m³) of EDB
N
0 1300 2600
Scale - Feet
Ponca City
Ash St.
Waverly
Highway 60
Okla 40
EDB Use and Storage Area
Bulk Loading Station
Cherokee Pipe Line
Williams Bros. Pipe Line
W-1
W-2
① (0.088)
② (0.093)
③ (0.080)
④ (0.064)
⑤ (0.074)
(0.052) ⑥
⑦ (0.052)
⑧ (0.048)
(0.050) ⑨
(0.067) ⑩
(0.074) ⑪
(0.068) ⑫
(0.056) ⑬
(0.065) ⑭
(0.062) ⑮
(0.090) ⑯
(0.089) ⑰
(0.071) ⑱
⑲ (0.077)
(0.131) ⑳

Figure 4. Average concentration of EDB in air at 20 sampling stations at Conoco Oil Refinery, Ponca City, Oklahoma.

in the air at the 20 sampling stations. The levels ranged from 0.13 µg/m^3 near the middle of the refinery to 0.05 µg/m^3 at stations south of the refinery. EDB was detected at all stations ranging from 0 to 1 mile away from the refinery.

Sources of EDB Emissions: Air sampling stations Nos. 19 and 20 were positioned directly south of the bulk loading station and the pipeline pumping station. Both were southeast of the lead mix storage area mixing facility and the leaded gasoline storage area. The EDB level at the bulk loading station (0.13 µg/m^3) was higher than that at the pumping station (0.078 µg/m^3), indicating that the bulk loading station is a source of EDB emission. The pumping station level is quite close to the 0.070 µg/m^3 average of all the other 18 stations. This distribution indicates that the pumping station is not a source of EDB emission.

The widespread geographical distribution cannot be attributed to the bulk loading station alone. Since no other definite source exists in the area, the EDB must be ubiquitous. The source is probably automobile traffic and retail gasoline stations.

Neglecting stations Nos. 19 and 20, there is little difference between the average of the stations ranging east and west from the plant fence line to a distance of 1/2 to 1 mile. The averages of the north and south transects, however, differ statistically at the 95% confidence level. The area to the south is rural while the area north is residential. Since the wind during the sampling period was from the north nearly as often as from the south, the difference is probably due to an "urban" effect, i.e., automobile traffic and retail gasoline stations.

EDB was not found on any of the filters, indicating that EDB was present exclusively as a vapor.

Water Samples

Two water samples were collected from the water treatment effluent at the southern boundary of the plant. The results of the analyses are given in Table 2. Similar levels of EDB, 0.17 and 0.14 ppb, were found in the samples collected at 0800 and 2000, respectively.

Table 2. EDB CONCENTRATIONS IN WATER FROM CONTINENTAL OIL COMPANY, PONCA CITY, OKLAHOMA

Sample No. and location	Concentration, µg/ℓ
W-1, Water treatment pond outlet	0.17
W-2, Water treatment pond outlet	0.14

Soil Samples

Soil samples were collected at the perimeter of the plant near air sampling stations Nos. 5, 9, 14, 18, 19, and 20.

EDB was not found in any of the soil samples. From the procedure used and the instrumental sensitivity, the detectable limit of EDB in a solid sample was 2 μg/kg.

Dustfall Samples

Dustfall samples were collected at the perimeter of the plant near air sampling stations Nos. 5, 9, 14, 18, 19, and 20.

No EDB was detected in any of the samples. Based upon the analytical sensitivity of the technique, the dustfall EDB was less than 60 $pg/cm^2/hr$. The lack of EDB in the dustfall agress with the finding of no particulate form of EDB.

Site Summary

The results of the analyses of the air samples indicate that the truck bulk loading station is a source of EDB emission. The terminal for shipment of leaded gasoline by pipeline is not a source. Furthermore, the associated leaded gasoline facilities and operations, e.g., lead mix storage, lead mix blending, and leaded gasoline storage, also are not sources of EDB emissions. The detectable levels of EDB up to 1 mile from the refinery are not due to emissions from the bulk loading station but may result from automobiles and retail gasoline stations. EDB was detected only as a vapor; no particulate EDB was found.

Very low levels of EDB, less than 0.2 ppb, were detected in the effluent from the water treatment facility. EDB was not detected in the soil samples or in the dustfall samples.

MOBIL OIL COMPANY, PAULSBORO, NEW JERSEY

Field sampling at the Mobil Oil Refinery was conducted on April 13, 1976. The samples collected were: 26 air (13 filters plus 13 charcoal traps), 13 soil, and 8 dustfall. No aqueous discharges were accessible.

Air Samples

The 26 air samples were collected at 13 sampling stations located northeast, east, southeast and south of the refinery. The Delaware River bordered the refinery on the north and a swamp bordered the plant on the west. No sampling stations were placed north or west of the plant. One station was placed at the Mobil bulk loading station. Four stations were placed south of this point, one was southeast, three were east and one was northeast. A station located north of the bulk loading area, at the edge of the Delaware River, was directed east of the lead mix storage and blending facilities and the pipeline pumping station. Two additional bulk loading stations (Sunoco and Exxon) were unexpectedly found operating near the Mobil facility; therefore, air sampling stations were installed near these potential sources. The air station at the Sunoco bulk loading outlet was 400 ft north of the Mobil bulk loading facility. The air sampler at the Exxon bulk loading station was 1,000 ft north-northeast of the Mobil bulk loading station. The last air station was placed 1,200 ft east of the Exxon facility and 1,800 ft northeast of the Mobil bulk loading station. By necessity, most of the sampling stations were placed to the east of the refinery. The wind was from the west more frequently than the east, and therefore the sites were downwind during most of the sampling. The air samples were collected for 18 hr. During this period, the wind was from the west northwest, west and west-southwest exclusively, as shown in Figure 5.

Geographical Distribution: The analytical data for the air samples are given in Table B-2. Figure 6 shows the 18-hr average concentrations of EDB in the air at the 13 sampling stations. The levels ranged from 0.20 $\mu g/m^3$ by the Exxon bulk loading station to 0.08 $\mu g/m^3$ 1 mile south of the Mobil bulk loading station. EDB was found at all air sampling stations.

Sources of EDB Emissions: Air sampling stations Nos. 2, 8, and 13 were situated directly east and downwind of the three bulk loading stations. The EDB air levels at these stations were: 0.19 $\mu g/m^3$ at Mobil, 0.15 $\mu g/m^3$ at Sunoco and 0.20 $\mu g/m^3$ at Exxon. The level at station No. 1, east of the lead mix storage, blending, and pipeline pumping stations, was lower, i.e., 0.12 $\mu g/m^3$. The remaining stations had an average EDB concentration of 0.10 $\mu g/m^3$. Again, the results indicate that the bulk loading facilities are sources of EDB emission. The lead mix area does not appear to be a major source of emission. The air levels of EDB decrease with distance away from the bulk loading stations and reach a lower limit of 0.08 to 0.10 $\mu g/m^3$. Comparable levels are reached at both 1 mile east (0.09 $\mu g/m^3$) and at 1 mile south (0.08 $\mu g/m^3$). These sites are downwind and crosswind, respectively, of the bulk loading stations, indicating that these EDB levels are ubiquitous. No EDB was found on the filter, indicating that the predominant physical form was vapor.

Soil Samples

Soil samples were collected near all air sampling stations except station No. 9.

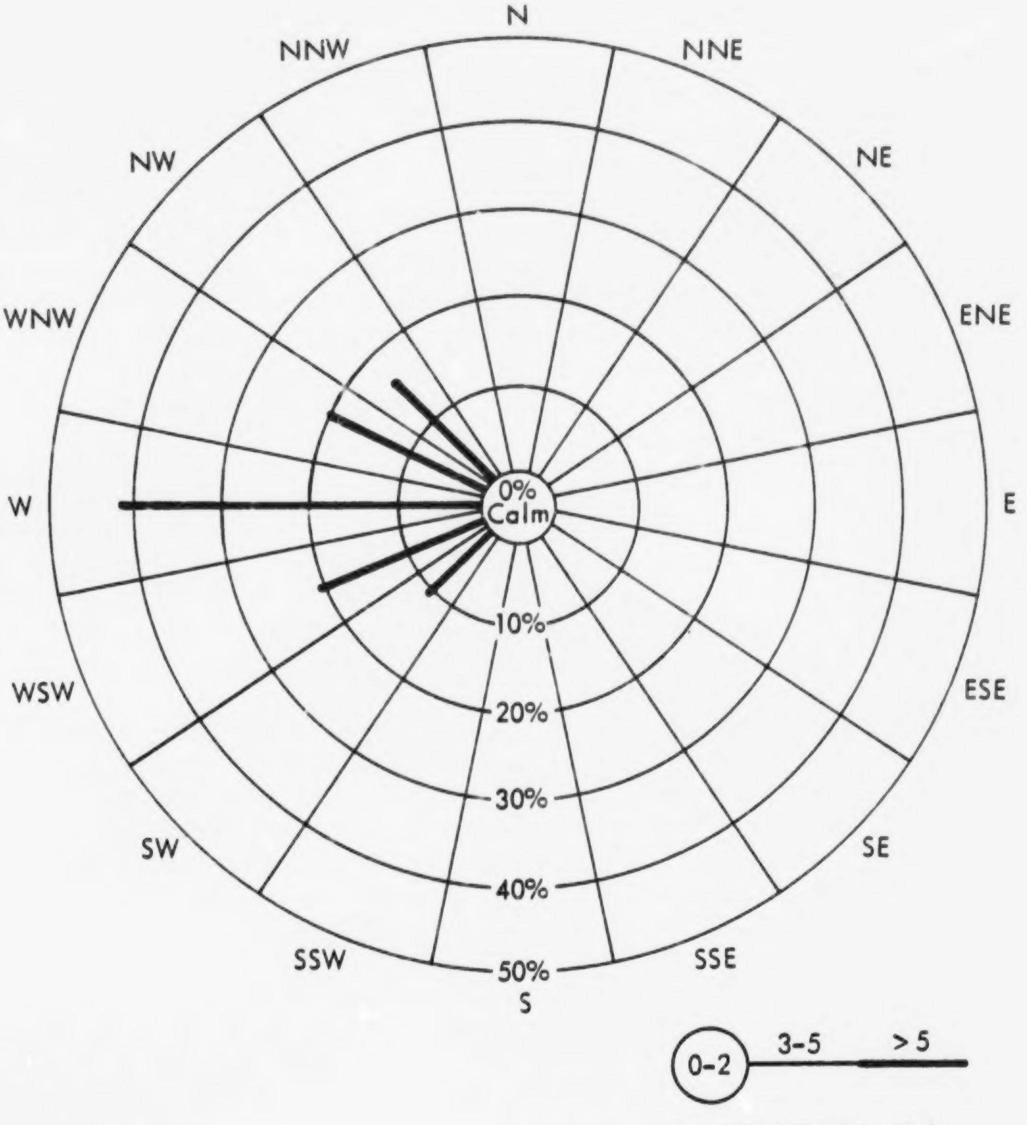
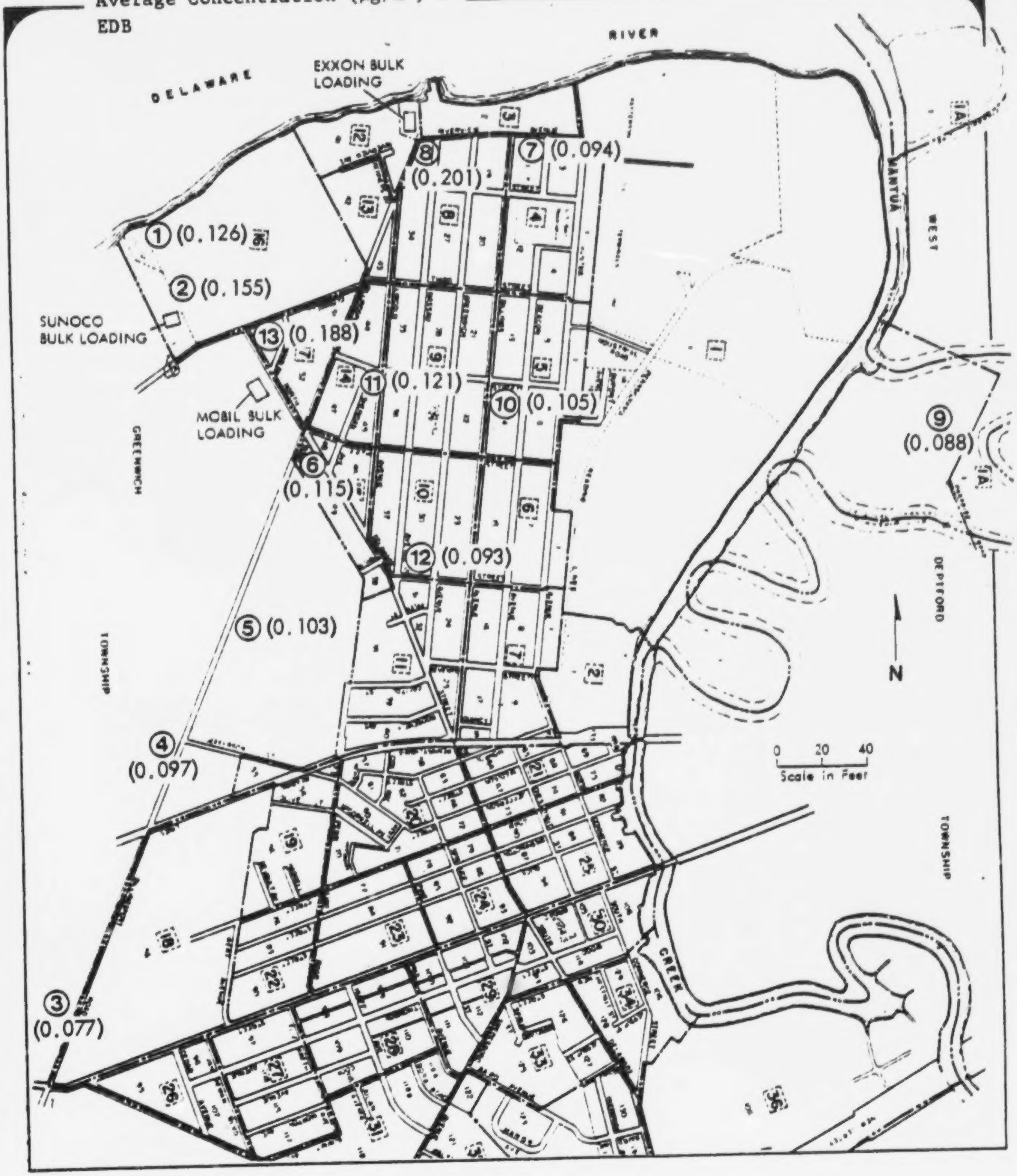


Figure 5. Wind patterns during sampling at Mobil Oil Refinery, Paulsboro, New Jersey.


Numbers in Parentheses Represent Average Concentration ($\mu g/m^3$) of EDB

DELAWARE
RIVER
EXXON BULK LOADING
① (0.126)
② (0.155)
SUNOCO BULK LOADING
⑬ (0.188)
MOBIL BULK LOADING
⑧ (0.201)
⑦ (0.094)
⑪ (0.121)
⑩ (0.105)
⑨ (0.088)
⑥ (0.115)
⑫ (0.093)
⑤ (0.103)
④ (0.097)
③ (0.077)
GREENWICH TOWNSHIP
WEST DEPTFORD TOWNSHIP
MANTUA
CREEK
N
0 20 40
Scale in Feet

Figure 6. Average concentration of EDB in air at 13 sampling stations at Mobil Oil Refinery, Paulsboro, New Jersey.

EDB was not detected in any of the soils, indicating that the level of EDB was less than 2 µg/kg of soil.

Dustfall Samples

Dustfall samples were collected from around the refinery at air sampling stations Nos. 1, 2, 3, 6, 8, 9, 10, and 13.

EDB was not found in any of the dustfall samples.

Summary

The results indicate that the truck bulk loading stations are sources of EDB emissions. The area containing the lead mix storage, lead mix blending, leaded gasoline storage, and the pipeline pumping does not appear to be a source. EDB levels detected up to 1 mile away from the sources are considered to be the baseline levels and are probably due to the contributions by gasoline-powered vehicles and retail gasoline stations.

EDB was detected in the vapor state only.

RETAIL GASOLINE STATIONS, PHOENIX, ARIZONA

Field sampling at the retail gasoline site in Phoenix, Arizona, was performed on February 26, 1976. Thirty-six air samples (18 filters and 18 charcoal traps) were collected. No water, soil, or dustfall samples were collected.

Air Samples

The 36 air samples were collected at 18 stations distributed to the north, south, east and west of the intersection of Shea Boulevard and 32nd Avenue. Four stations were placed in each direction at 1/8 to 1 mile from the intersection. Two stations were placed at the southwest and northeast corners of the intersection, adjacent to retail gasoline stations. The air samples were collected for approximately 18 hr. Throughout this period the wind was predominantly from the west and east, as seen in Figure 7. The traffic passing through the intersection was reported to be 38,000 vehicles per day.[3]

Geographical Distribution: The analytical data for the air samples are presented in Table B-3. Figure 8 shows the 18-hr average concentrations of EDB in the air at the 18 stations. The levels ranged from a high of 0.50 µg/m^3 at the gasoline stations to a low of 0.20 µg/m^3 at 1/2 mile south of the intersection. The sample taken 1 mile south of the intersection was lost. EDB was detected at all sampling stations.

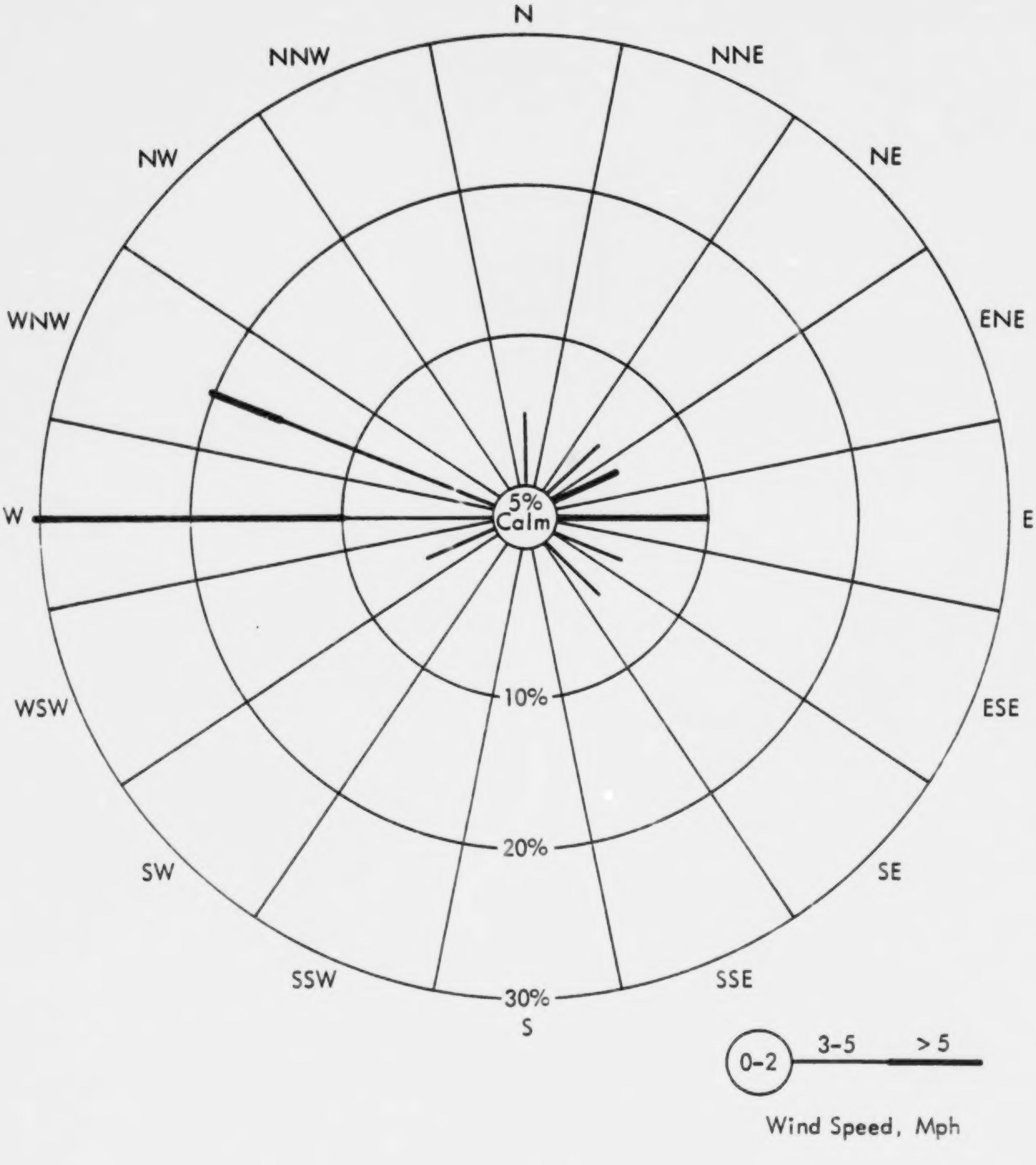


Figure 7. Wind patterns during sampling at the retail gasoline site, Phoenix, Arizona.

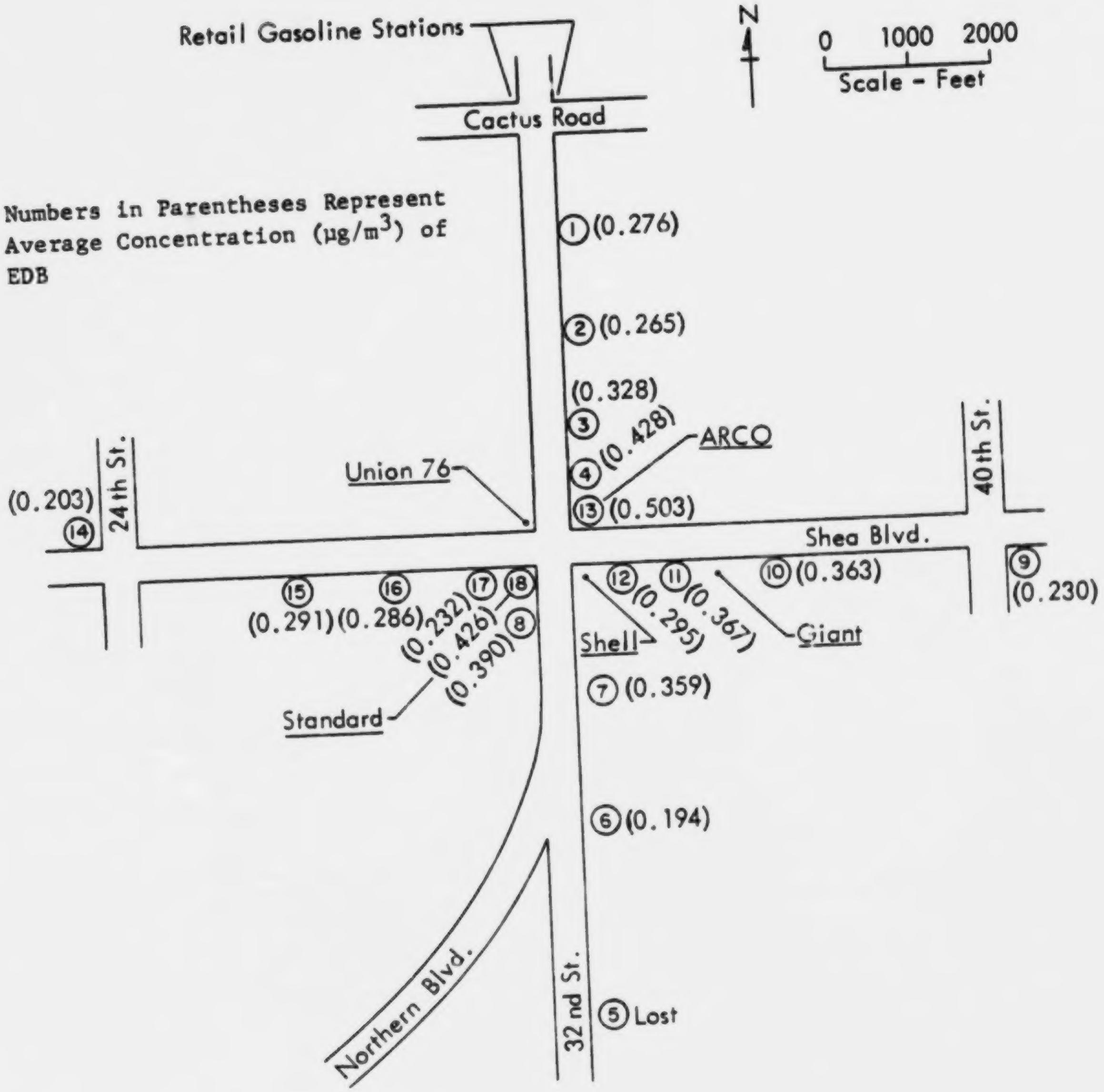

Retail Gasoline Stations
N
0 1000 2000
Scale - Feet
Cactus Road
Numbers in Parentheses Represent Average Concentration (μg/m³) of EDB
① (0.276)
② (0.265)
(0.328)
③
④ (0.428)
ARCO
⑬ (0.503)
Union 76
(0.203)
⑭
24th St.
40th St.
Shea Blvd.
⑨
(0.230)
⑩ (0.363)
⑮ ⑯ ⑰ ⑱
(0.291) (0.286) (0.232)
(0.426)
(0.390)
⑧
⑫ ⑪
(0.295)
(0.367)
Shell
Giant
Standard
⑦ (0.359)
⑥ (0.194)
Northern Blvd.
32 nd St.
⑤ Lost

Figure 8. Average concentration of EDB in air at 18 sampling stations at the retail gasoline site, Phoenix, Arizona.

Sources of EDB Emissions: Figure 9 shows the air levels of EDB along the north-south and the east-west transects. The obvious peaks at the intersection show that the retail gasoline stations are definite sources of EDB emission. The levels decrease rapidly with distance away from the intersection and reach a lower limit of 0.20 to 0.26 $\mu g/m^3$. The high levels at air stations Nos. 11 and 10, 1/4 and 1/2 mile east of the intersection, can be traced to the Giant Retail gasoline station, located between the two samplers. This again indicates that the retail gasoline stations are point sources of EDB emissions. At the sites farthest from the gasoline stations in all four directions, there is little difference in the EDB levels. This indicates that in addition to the set of four retail gasoline stations which appears as a point source, there is an elevated baseline level of EDB. All of the retail gasoline stations across the metropolitan area contribute to this level.

EDB was not detected on the filters, showing that the vapor form predominated.

Summary

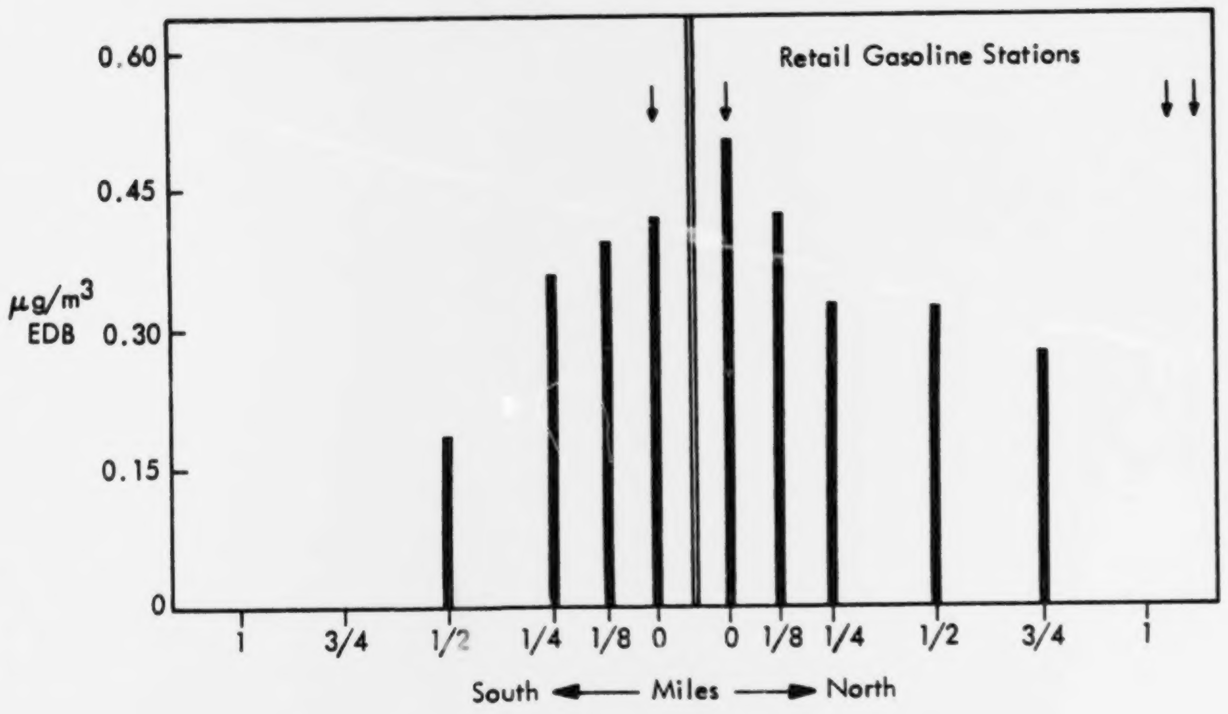
The results showed that retail gasoline stations are sources of EDB emissions. However, levels of EDB higher than would be predicted were found over a wide geographic range. These levels constitute a baseline concentration that is attributed partially to the combined emissions from all retail gasoline stations. Because of this background level, the emissions from the retail gasoline could not be discerned beyond 1/8 mile. All EDB was found to exist in the vapor form only.

RETAIL GASOLINE STATIONS, LOS ANGELES, CALIFORNIA

Field sampling at a retail gasoline site in Los Angeles, California, was performed on March 2, 1976. Twenty-eight air samples (14 filters and 14 charcoal traps) were collected. Two water runoff samples were collected following a rain. Soil and dustfall samples were not collected.

Air Samples

The 28 air samples were collected at 14 stations positioned from 0 to 3/4 mile to the north, south, east, and west of the intersection of Del Amo and Bellflower boulevards. Four stations were placed to the north, three to the south, two to the east, three to the west, and two were at the intersection, adjacent to retail gasoline stations. Air samples were collected for 13 hr. Sampling was terminated due to the onset of a heavy rain. The wind during the hours of sampling was almost entirely from the east as shown in Figure 10. The vehicular traffic through the intersection was 46,000/day.[4]



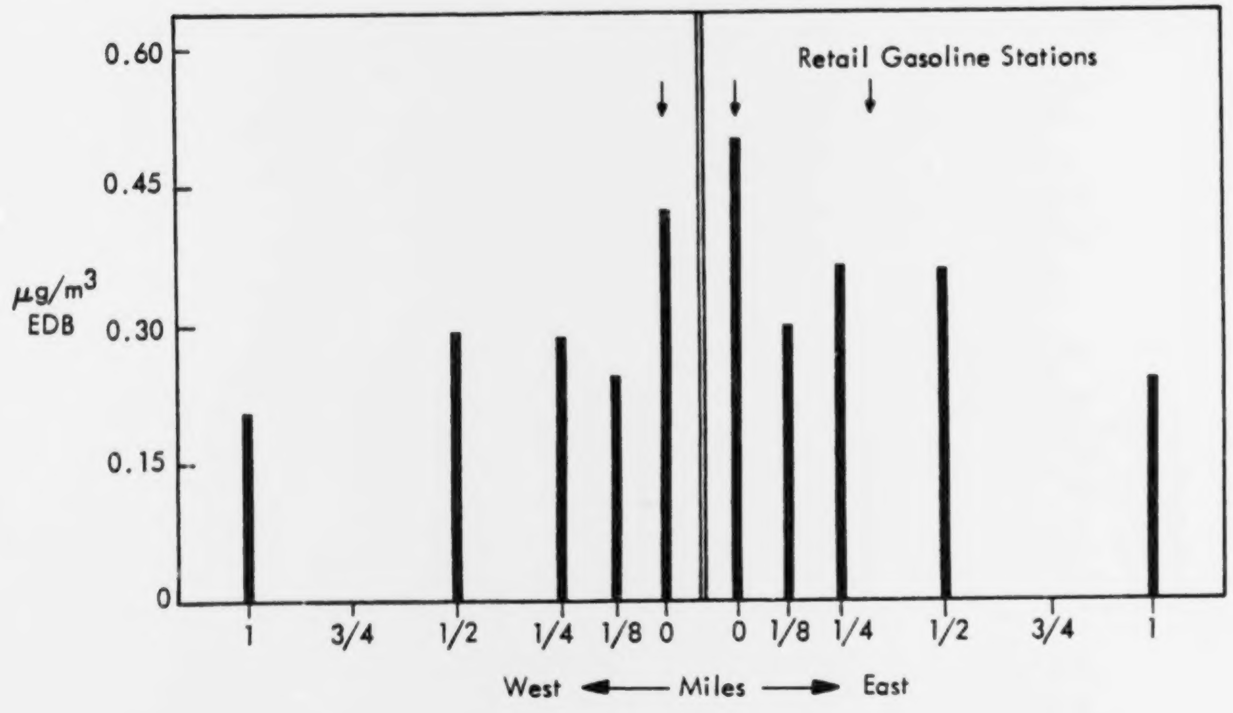


Figure 9. Average concentration of EDB in air at sampling stations north, south, east and west of the retail gasoline stations, Phoenix, Arizona.

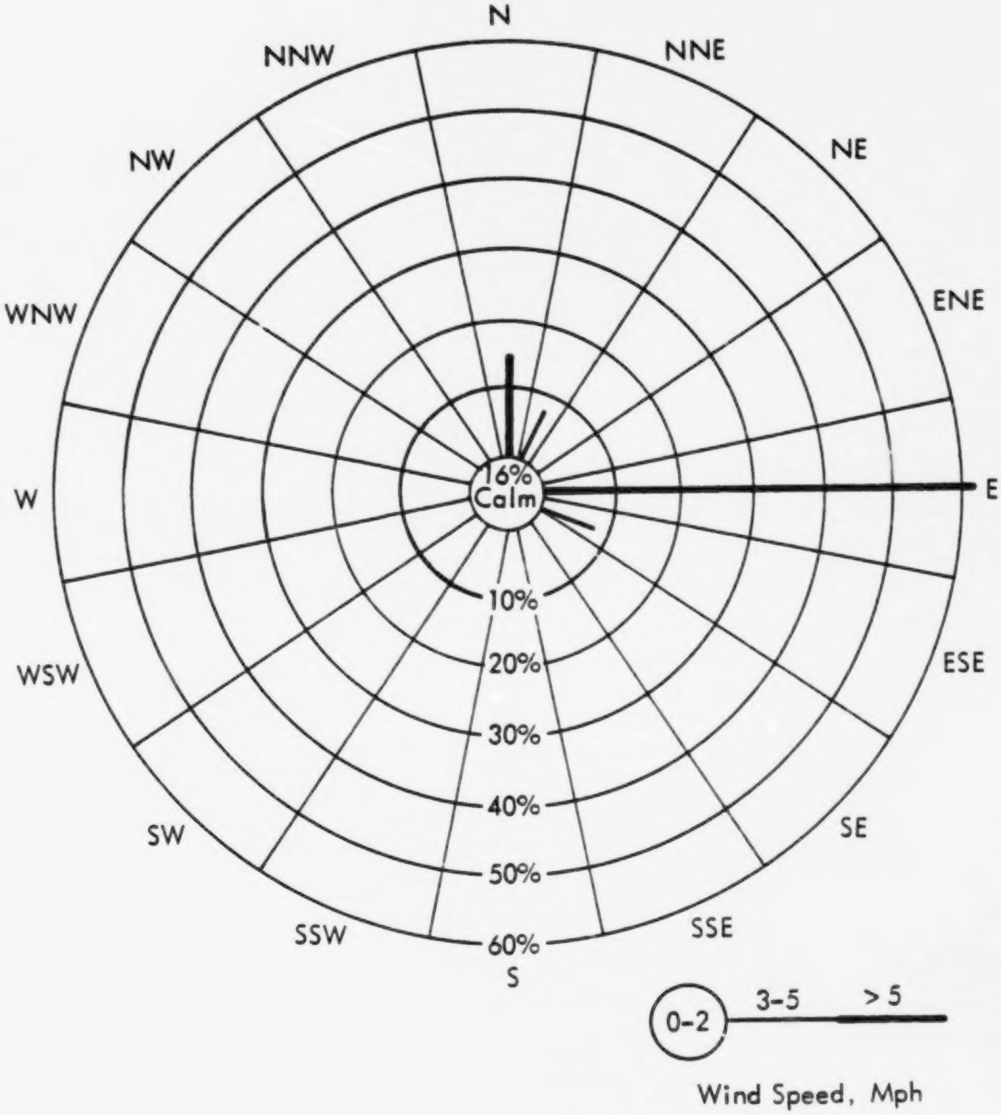


Figure 10. Wind patterns during sampling at the retail gasoline site, Los Angeles, California.

Geographical Distribution: Table B-4 lists the analytical data for the air samples. The 13-hr average EDB concentrations at the 14 stations are shown in Figure 11. The highest value was 0.19 µg/m^3 near a gasoline station; the lowest value was 0.09 µg/m^3 found at six sites ranging from 1/8 to 3/4 mile away from the intersection in all four directions. EDB was detected at all sampling locations.

Sources of EDB Emissions: The EDB levels along the north-south and east-west transects are shown in Figure 12 along with the location of additional nearby retail gasoline stations. The levels have a definite maximum at the intersection and then drop within 1/8 mile to a fairly constant level of 0.1 µg/m^3. The EDB distribution indicates that the three retail gasoline stations are sources of EDB emissions. The failure of these levels to drop to zero or to be strongly influenced by the easterly wind indicates that the level of 0.1 µg/m^3 is a baseline value. The baseline level of EDB is presumably due to the summed contributions of all the retail gasoline stations in the region. A contribution by vehicular traffic is also possible. All EDB was found in the form of a vapor.

Water Samples

Two water samples were collected as runoff water during a light rain that occurred at around 1500 on March 2. One sample was collected at the intersection of Del Amo and Bellflower boulevards "downstream" of the stations and the second sample was collected 1/2 mile south of the intersection. Table 3 gives the results of the analysis of these samples. The level detected at the intersection, 0.17 ppb, was slightly higher than the value of 0.11 ppb detected at 1/2 mile south. It is not certain whether the EDB in the water came from washout of the air or from a "wash off" of the streets, driveways, etc. The fact that the ratio of levels, 0.17/0.11 ppb, is similar to the air levels at those two sites, 0.19/0.10 µg/m^3, suggests that the EDB is from a washout of the air.

Table 3. EDB CONCENTRATIONS IN RUNOFF WATER AT THE
RETAIL GASOLINE SITE, LOS ANGELES, CALIFORNIA

Sample No. and location	Volume	ng	µg/ℓ
W-1, Bellflower and Del Amo	200 ml	34	0.17
W-2, South 1/2 mile	200 ml	22	0.11

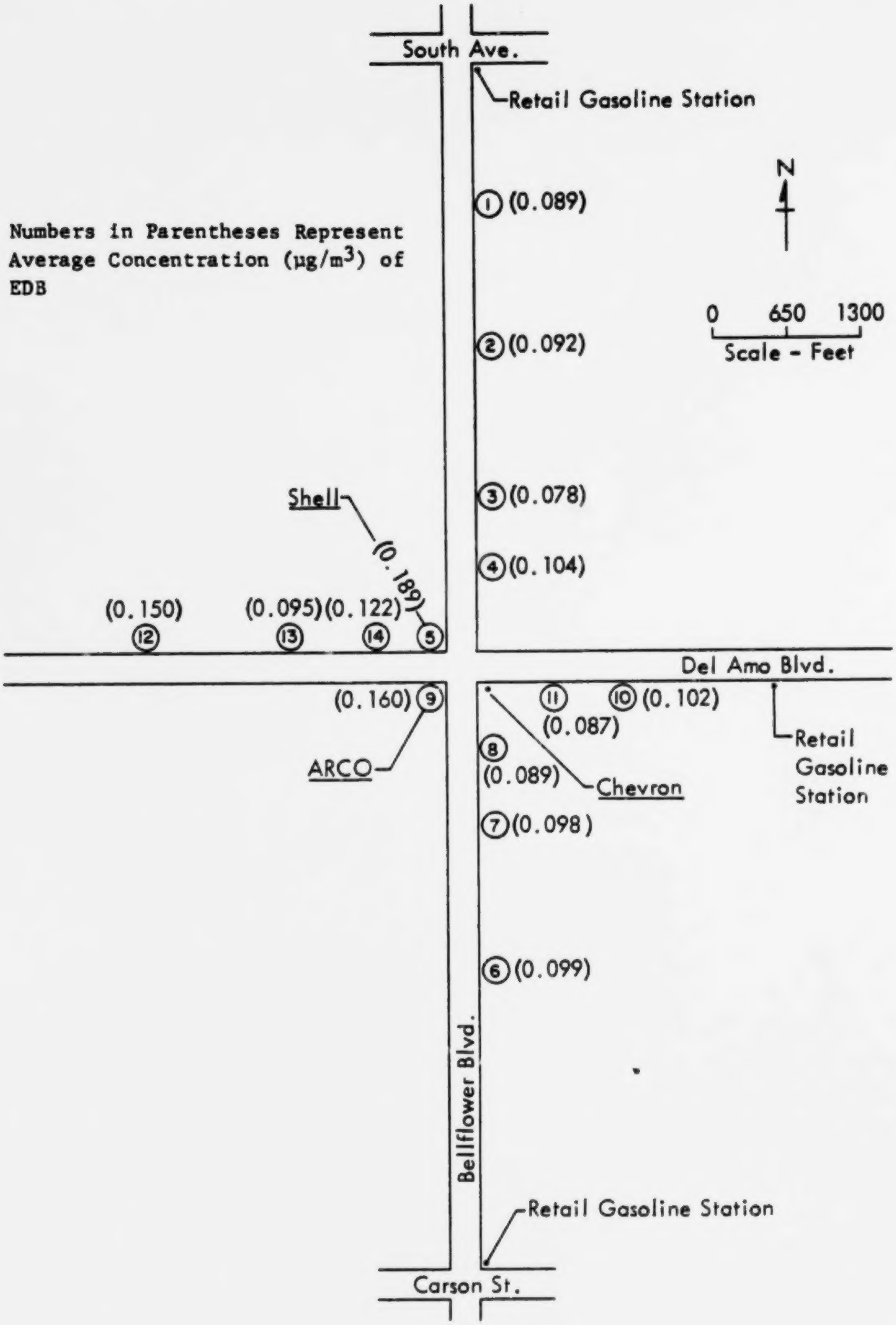

South Ave.
Retail Gasoline Station
N
Numbers in Parentheses Represent Average Concentration (µg/m³) of EDB
① (0.089)
0 650 1300
Scale - Feet
② (0.092)
Shell
③ (0.078)
(0.189)
④ (0.104)
(0.150) ⑫
(0.095) ⑬
(0.122) ⑭
⑤
Del Amo Blvd.
(0.160) ⑨
ARCO
⑪ (0.087)
⑩ (0.102)
Retail Gasoline Station
⑧ (0.089)
Chevron
⑦ (0.098)
⑥ (0.099)
Bellflower Blvd.
Retail Gasoline Station
Carson St.

Figure 11. Average concentration of EDB in air at 14 sampling stations at the retail gasoline site, Los Angeles, California.

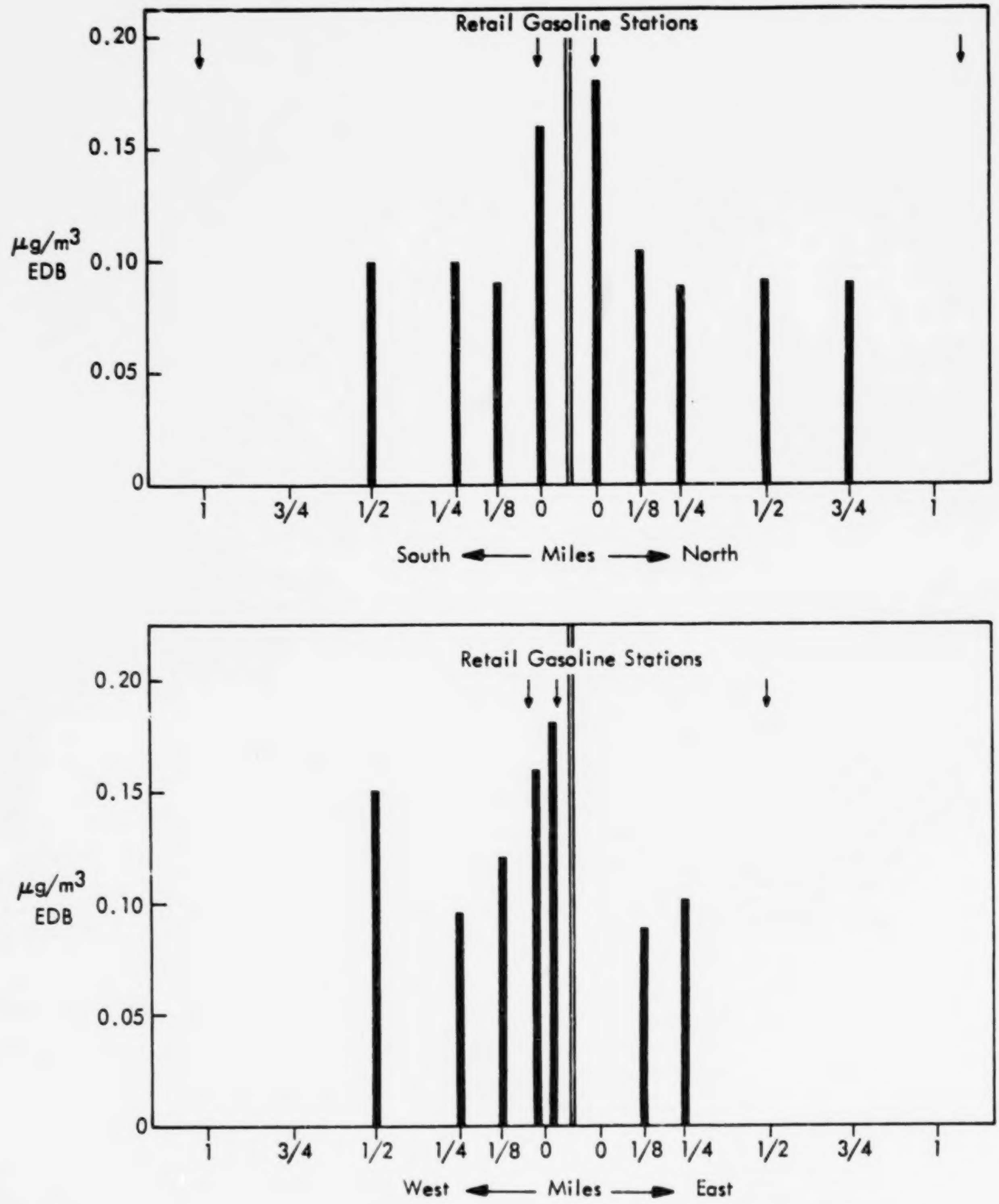


Figure 12. Average concentration of EDB at sampling stations north, south, east and west of the retail gasoline site, Los Angeles, California.

Summary

The cluster of retail gasoline stations was demonstrated to be a source of EDB emissions. The realm of influence of this type of source does not extend beyond 1/8 mile in any direction. This is due to a baseline level of EDB in air that is about 1/2 of the point source level. The ubiquitous nature of airborne EDB is apparently a result of all gasoline stations functioning as sources of EDB emissions. EDB was found in runoff water following a rainfall. Its presence appears to be due to a washout of the ambient air. All EDB found in the air was in the vapor form.

RETAIL GASOLINE STATIONS, CAMDEN, NEW JERSEY

Field sampling was conducted near two retail gasoline stations on April 15, 1976. Six air samples (3 filters and 3 charcoal traps) were collected. No water, soil, or dustfall samples were taken.

Air Samples

The six air samples were taken with three samples positioned on Haddon Avenue at 0, 0.2, and 0.6 mile southeast of its intersection with Euclid Street. The first station was directly southeast of two retail gasoline stations. Air was sampled for 12 hr. During this time, the wind was principally from the south and southwest, as shown in Figure 13. Vehicular traffic at the intersection along Haddon Avenue was 13,000 vehicles/day.[5]

Geographical Distribution: The results of the sample analyses are given in Table B-5 and are shown on the map in Figure 14 as 12-hr averages. The samples collected at stations Nos. 1 and 2 had identical levels of EDB (0.48 $\mu g/m^3$). The sample collected at station No. 3, 0.6 mile southeast of the gasoline stations, contained 0.38 $\mu g/m^3$ EDB.

Sources of EDB Emissions: During the sampling period, the stations were all crosswind or partially upwind of the retail gasoline stations. For this reason, it was not possible to establish whether these gasoline stations were sources of EDB emissions. The baseline levels at the station farthest from the gasoline stations, 0.38 $\mu g/m^3$, is notably higher than expected. The Camden-Philadelphia area has a very high population density with high traffic density and numerous retail gasoline stations. The sampling stations were located downwind of most of the metropolitan areas. Furthermore, three major oil refineries, Texaco, Gulf, and Arco, are located within 5 miles upwind of the Camden sampling sites (see Figure A-4). Those three refineries, plus the Mobil refinery at Paulsboro, account for nearly 3.5% of the production of gasoline in the United States.[6] All these factors combined can be expected to contribute to a high baseline level of EDB.

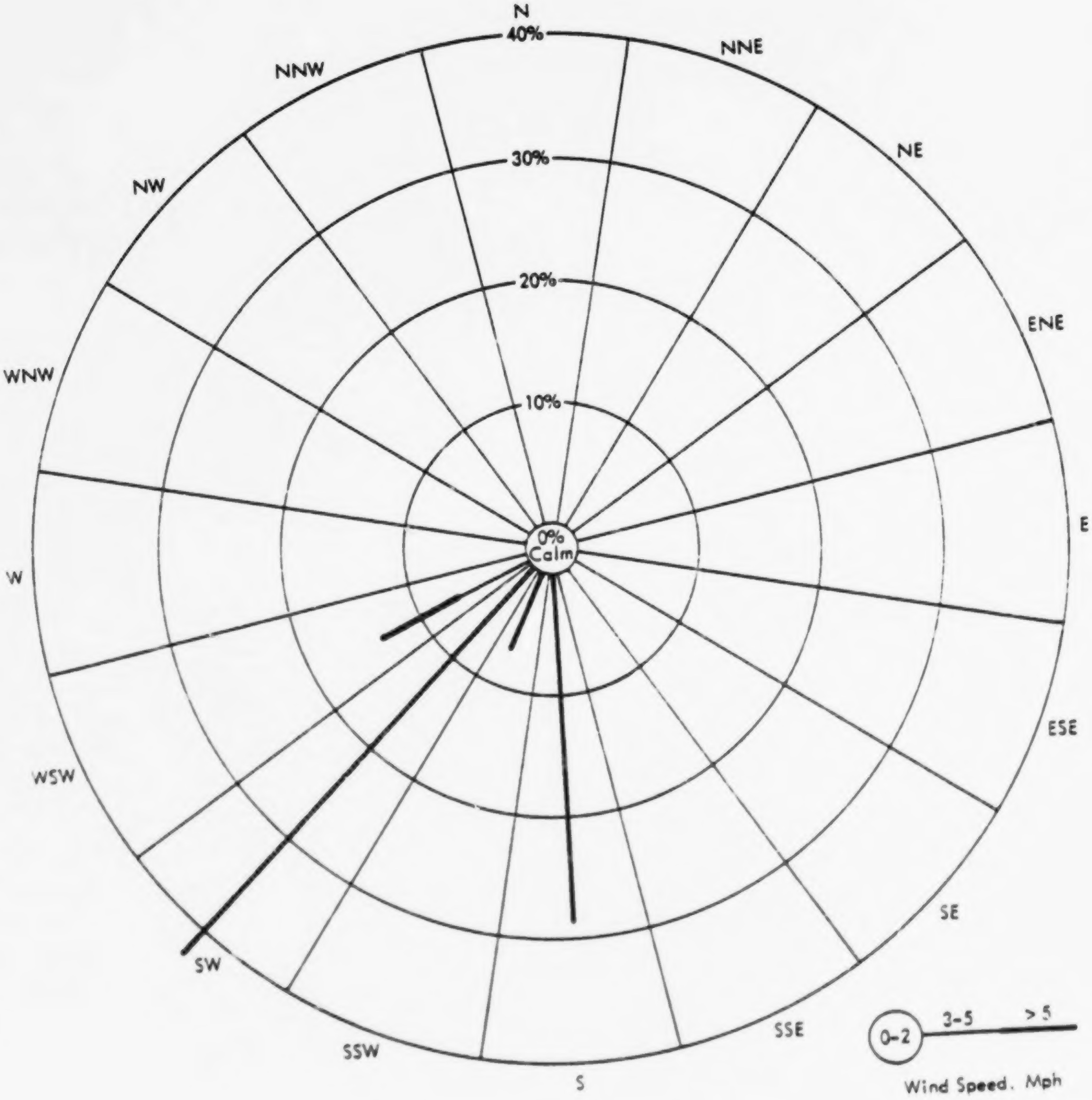
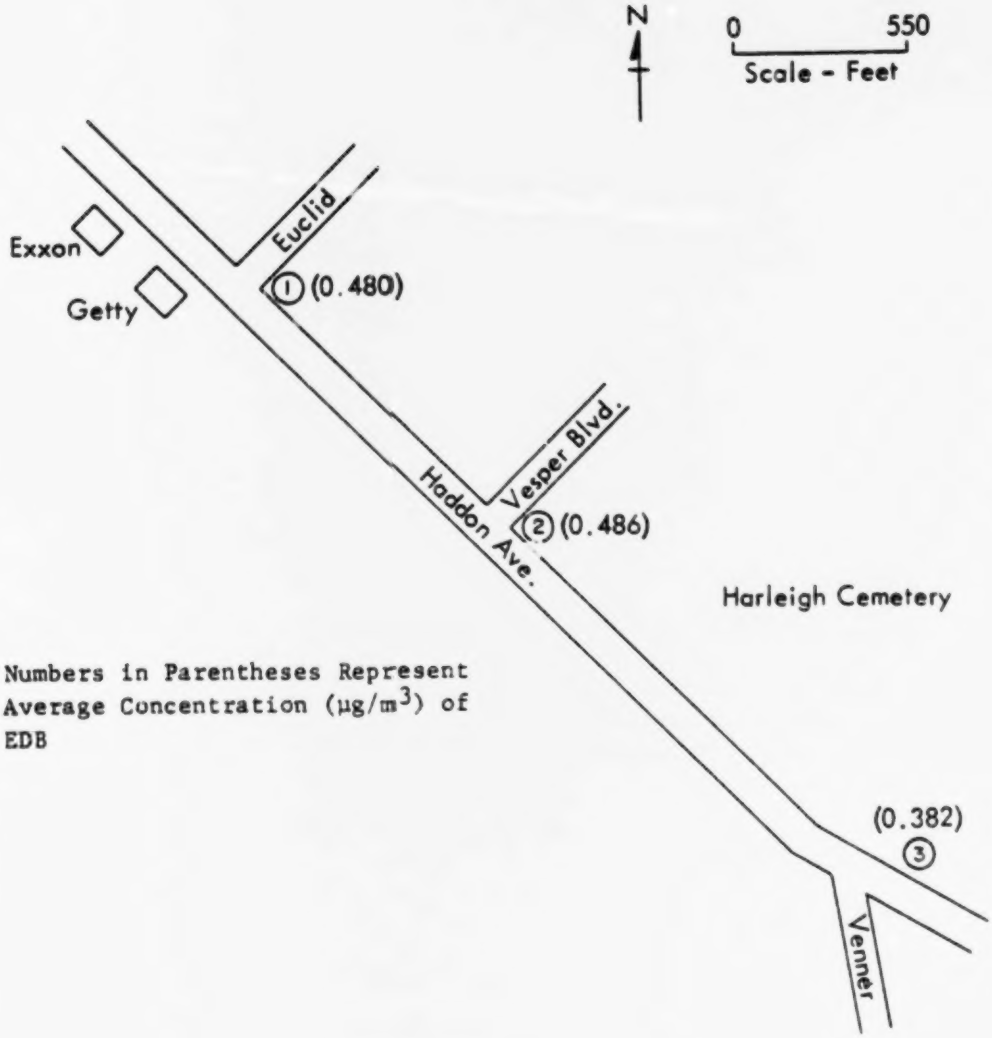


Figure 13. Wind patterns during sampling at the retail gasoline site, Camden, New Jersey.


N
0
550
Scale - Feet
Exxon
Getty
Euclid
① (0.480)
Vesper Blvd.
Haddon Ave.
② (0.486)
Harleigh Cemetery
(0.382)
③
Venner

Numbers in Parentheses Represent Average Concentration (μg/m^3) of EDB

Figure 14. Average concentration of EDB at three sampling stations at the retail gasoline site, Camden, New Jersey.

As before, all EDB was found to be present in the vapor state only.

Summary

The effect of the retail gasoline stations on the level of EDB in air was not discernible. The ambient air level of EDB, however, was higher than expected. The high background level of EDB may be due to the Philadelphia-Camden area's having a high population density, high traffic density, and numerous retail gasoline stations, plus the presence of four major oil refineries at the southwest section of the city.

HIGHLY TRAFFICKED SITE, PHOENIX, ARIZONA

Field sampling at the highly trafficked site in Phoenix, Arizona, was performed on February 24, 1976. Twenty air samples (10 filters and 10 charcoal traps) were collected. No water, soil, or dustfall samples were collected.

Air Samples

The 20 air samples were collected at 10 stations placed east and west of Interstate 17 and 27th Avenue on Montebello. Five stations each were east and west at distances of 0 to 1 mile from the two roadways. The air samples were collected continuously for 18 hr. During this period the wind was from the west 60% of the time and from the east 30% of the time. Figure 15 shows the wind behavior during the sampling period. The traffic on I-17 and 27th Avenue was estimated to be 95,000 vehicles/day.[3]

Geographical Distribution: The analytical data for the air samples are presented in Table B-6. Figure 16 shows a map of the site with the 18-hr average concentrations of EDB. The levels ranged from 0.31 $\mu g/m^3$ at 1 mile west of the Interstate to 0.41 $\mu g/m^3$ immediately west of the Interstate. EDB was detected at all the sampling stations.

Sources of EDB Emissions: Figure 17 shows the air levels at the stations east and west of I-17 and 27th Avenue. No distinct trend in the EDB levels can be detected. The results do not indicate that a highly trafficked roadway is a discernible source of EDB emission.

All detected EDB was in the vaporous form.

Summary

A single heavily trafficked roadway was not a discernible line source of EDB emission. However, these results are not evidence that automobiles themselves are not mobile sources of EDB emissions. They imply that automobile traffic is so omnipresent that it is not possible to isolate a single traffic-based source.

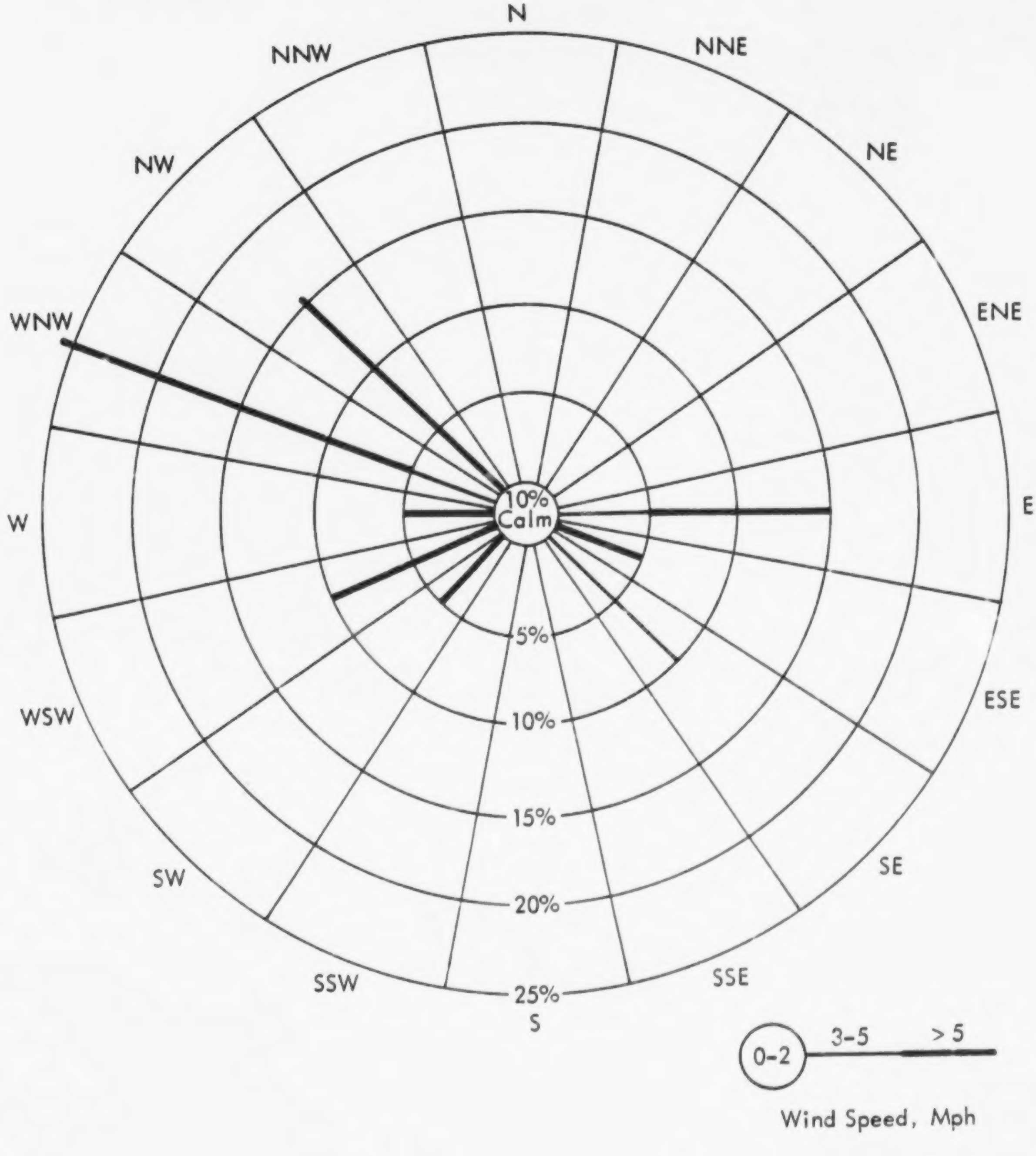
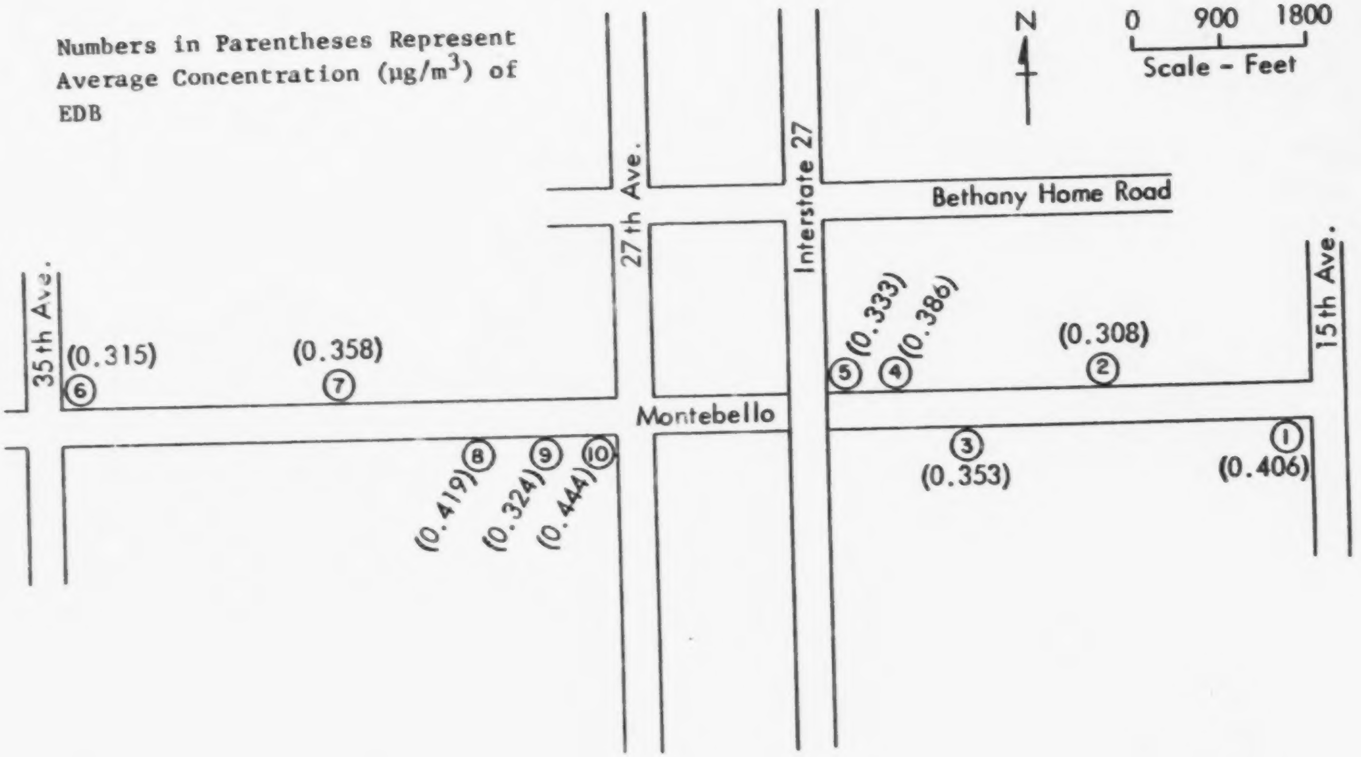


Figure 15. Wind patterns during sampling at the highly trafficked site, Phoenix, Arizona.


Numbers in Parentheses Represent Average Concentration (µg/m^3) of EDB

0
900
1800
Scale - Feet
N
Bethany Home Road
Interstate 27
27th Ave.
35th Ave.
15th Ave.
Montebello
⑥ (0.315)
⑦ (0.358)
⑧ (0.419)
⑨ (0.324)
⑩ (0.444)
⑤ (0.333)
④ (0.386)
② (0.308)
③ (0.353)
① (0.406)

Figure 16. Average concentration of EDB at 10 sampling stations at the highly trafficked site, Phoenix, Arizona.

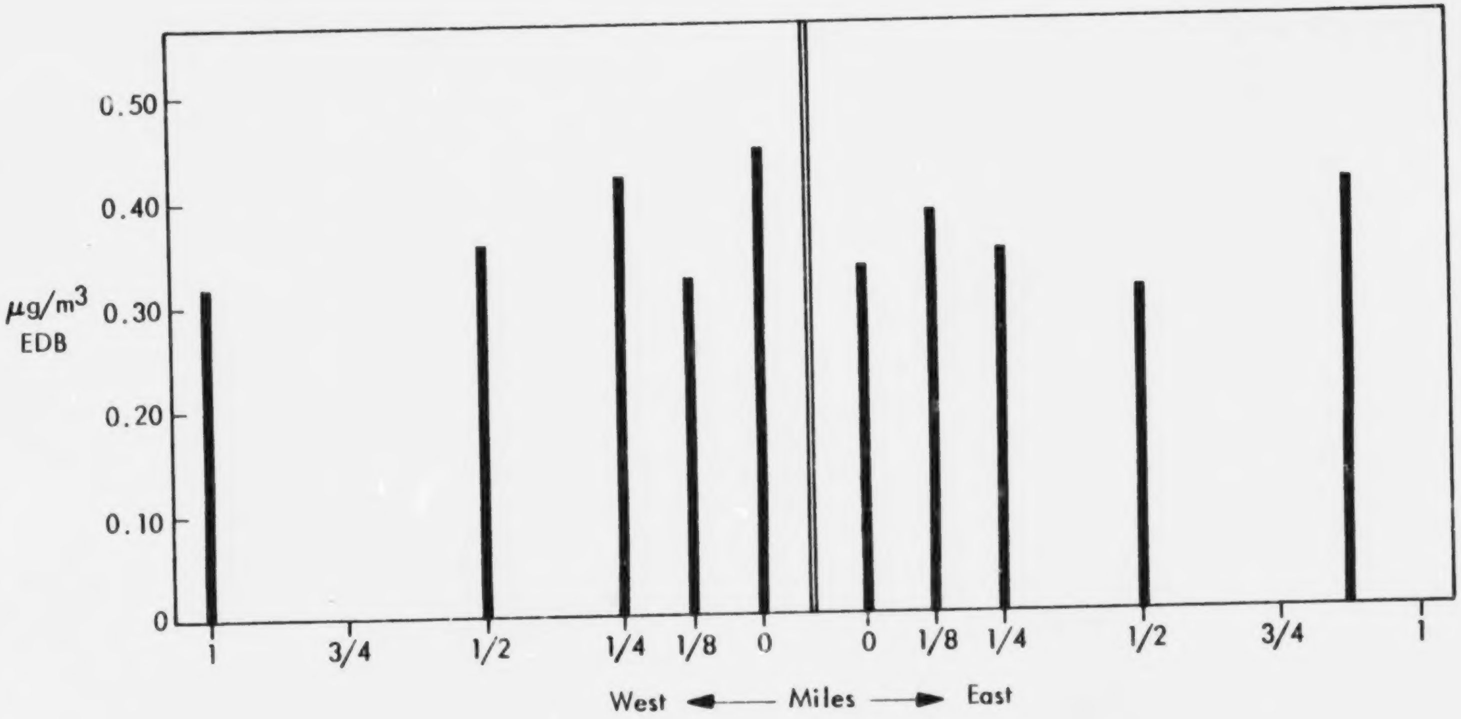


Figure 17. Average concentration of EDB at sampling stations east and west of the highly trafficked site, Phoenix, Arizona.

HIGHLY TRAFFICKED SITE, LOS ANGELES, CALIFORNIA

Field sampling was performed on March 4, 1976, at a site featuring a heavily trafficked freeway in Los Angeles, California. A total of 18 air samples (9 filters and 9 charcoal traps) were collected. No water, soil, or dustfall samples were collected.

Air Samples

The nine air sampling stations used to collect the 18 air samples were arranged north and south of the San Diego Freeway (Interstate 405) on Studebaker Road. Five stations were from 0 to 1 mile north of the freeway while four were from 1/8 to 3/4 mile south. Normally the winds would come off the coast and blow across the freeway from south to north. During the 18-hr sampling period, which followed a period of severe weather, the wind was from the northeast to north-northeast 30% of the time and from the east 48% of the time, as shown in Figure 18. The San Diego Freeway, at Studebaker Road, carries an average traffic load of 144,000 vehicles/day.[4]

Geographical Distribution: Table B-7 lists the analytical data for the 18 air samples. A map of the area is shown in Figure 19, with the 18-hr average concentrations of EDB. The concentrations ranged from 0.16 $\mu g/m^3$ immediately north of the freeway to 0.12 $\mu g/m^3$ at several sites south of the freeway. EDB was found at all stations along the 1-3/4 mile transect.

Sources of EDB Emissions: The levels of EDB in the air around the freeway are shown graphically in Figure 20. All the stations from 1/8 to 3/4 mile south recorded very similar levels of EDB. Comparable levels of EDB were also found from 1/2 to 1 mile north of the freeway. Only the site immediately north showed a relatively higher level of EDB. While the difference is not large, it suggests that the freeway traffic is a source of EDB emission. The wind patterns during the sampling period were not favorable for observing such an effect at the 0-mile north station. The 1/8-mile south station was too distant to be greatly influenced by the emissions from the traffic. EDB collected at these stations was all in the vapor form.

Summary

The heavily trafficked freeway could be a line source of EDB emission. The EDB concentration near the edge of the road, 0.16 $\mu g/m^3$, was slightly higher than the levels of 0.12 to 0.14 $\mu g/m^3$ recorded at more distant sites. The generally similar levels at all stations, however, indicate that EDB is ubiquitous.

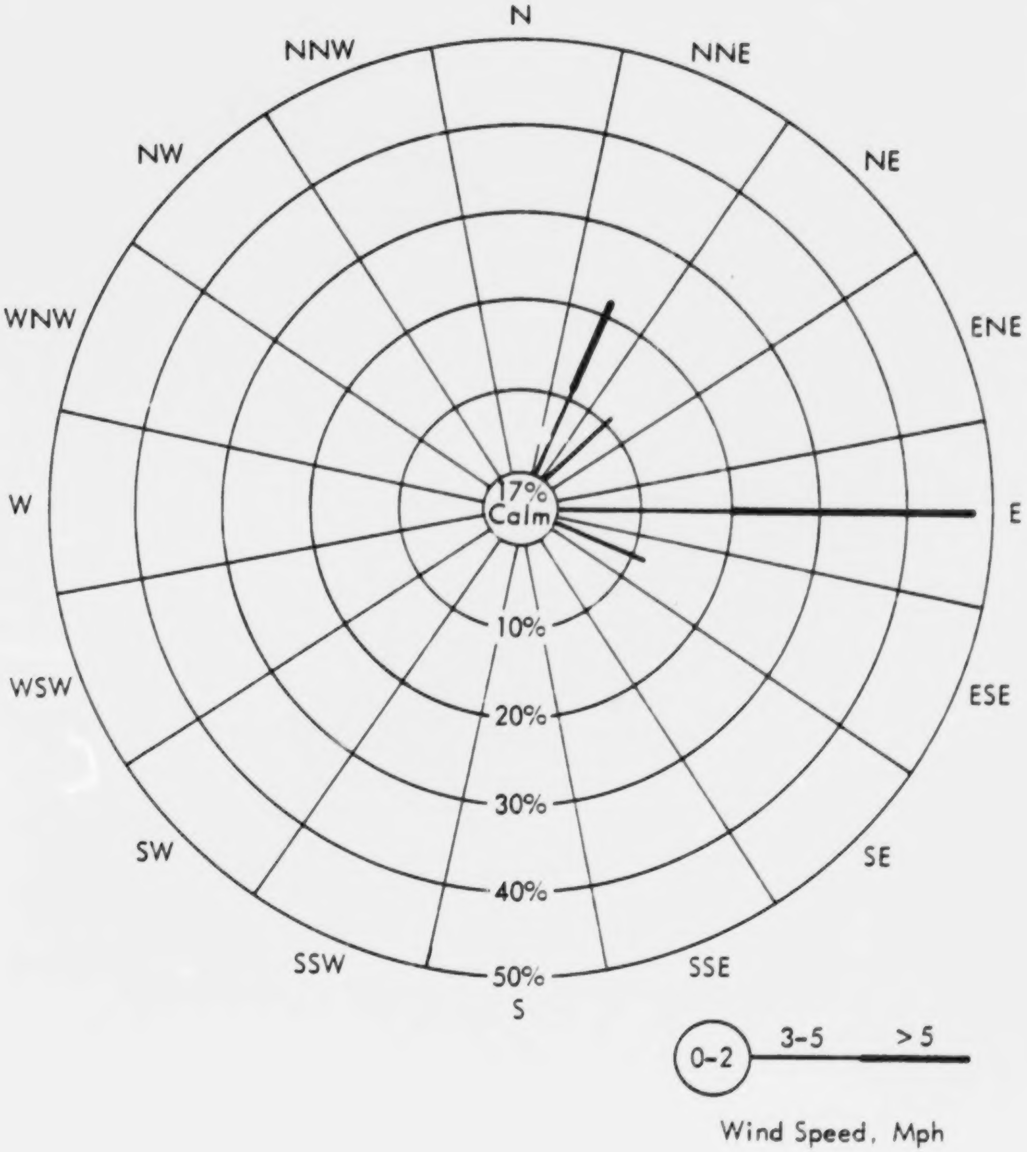
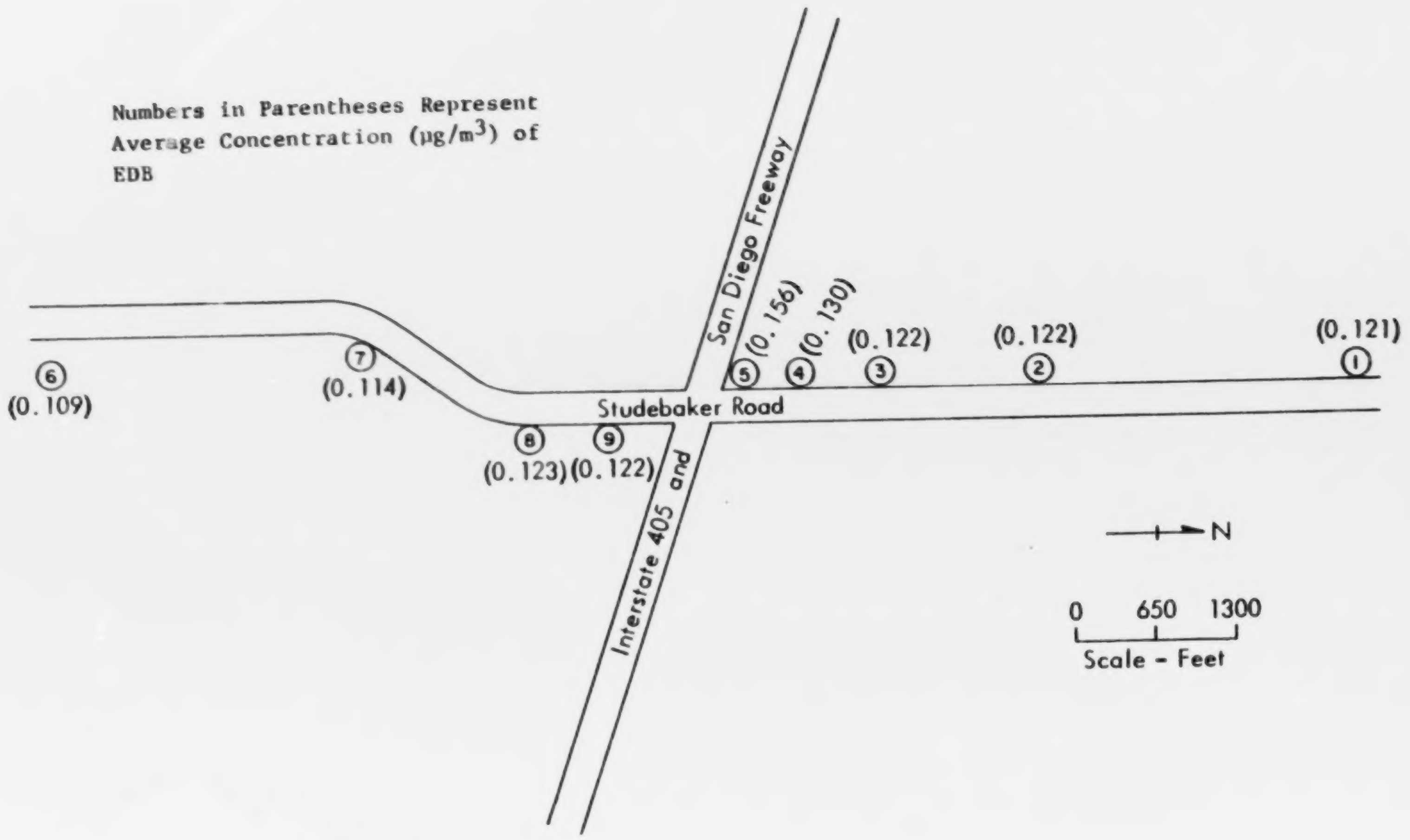


Figure 18. Wind patterns during sampling at the highly trafficked site, Los Angeles, California.



Numbers in Parentheses Represent Average Concentration ($\mu g/m^3$) of EDB

San Diego Freeway
Interstate 405 and
Studebaker Road
① (0.121)
② (0.122)
③ (0.122)
④ (0.130)
⑤ (0.156)
⑥ (0.109)
⑦ (0.114)
⑧ (0.123)
⑨ (0.122)
N
0 650 1300
Scale - Feet

Figure 19. Average concentration of EDB at nine sampling stations at the highly trafficked site, Los Angeles, California.

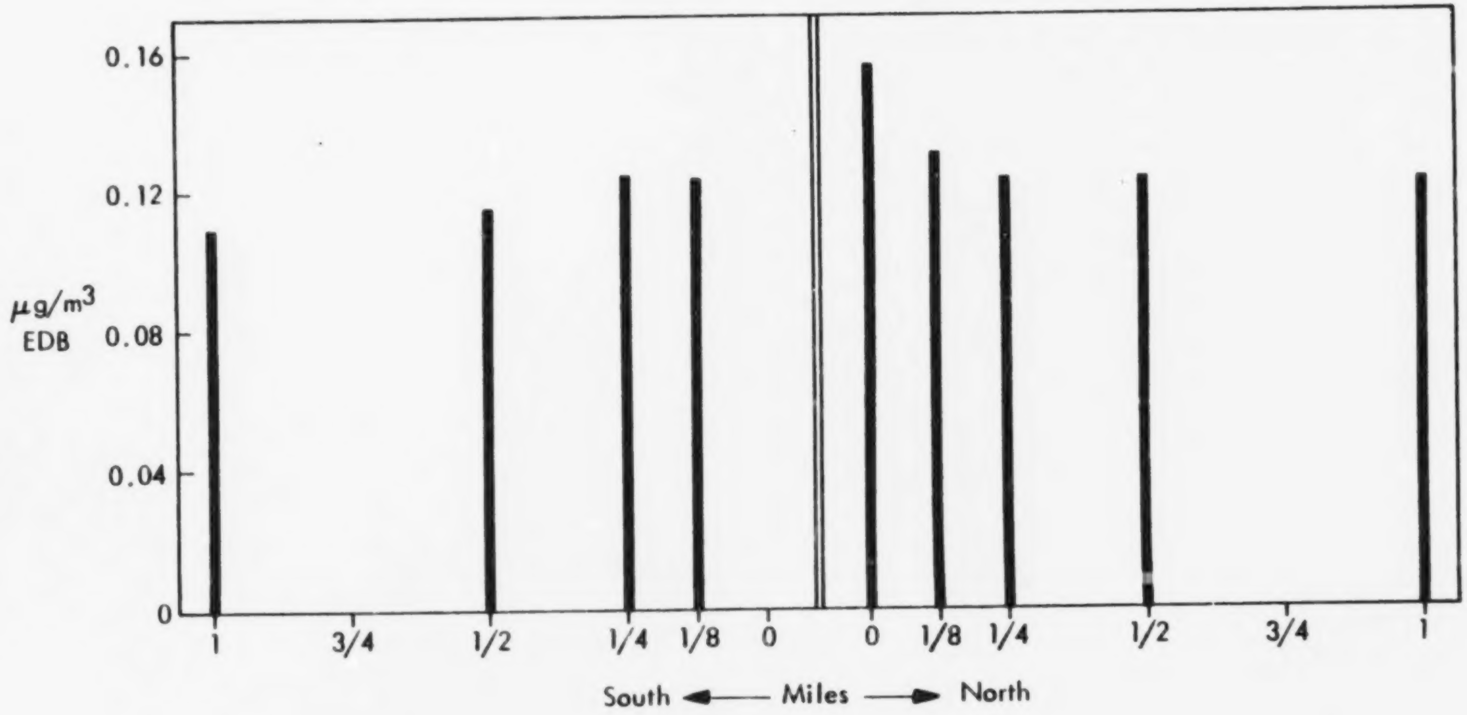


Figure 20. Average concentration of EDB at sampling stations north and south of the highly trafficked site, Los Angeles, California.

SUBURBAN LOW TRAFFIC SITE, KANSAS CITY, MISSOURI

Field sampling was conducted on March 18, 1976, at a low traffic suburban site in east Kansas City, Missouri. Two air samples (1 filter and 1 charcoal trap) were collected.

Air Samples

A single air sampling station was placed at 12219 E. 61st Street, Kansas City, Missouri. The area was suburban with no heavily trafficked roadways within 1 mile. The nearest gasoline stations were over 1 mile west of the site. No weather data were taken during the sampling. The weather, however, was fair and no precipitation occurred during the sampling. While no traffic data were available for the area sampled, it was estimated to be less than 100 vehicles/day. This area was sampled primarily to establish the EDB level in a suburban area, away from traffic and retail gasoline stations.

Levels of EDB: The analytical data for the suburban site are given in Table B-8. The location and the 18-hr average concentrations are given on the map shown in Figure 21. The level of 0.06 $\mu g/m^3$ represents a baseline level of EDB for an area removed from the expected sources, i.e., retail gasoline stations and heavy traffic.

Summary

The level of EDB in a suburban area was found to be 0.06 $\mu g/m^3$. This represents a baseline value for an area removed from heavy traffic and retail gasoline stations. The observed EDB was found in the vapor form.

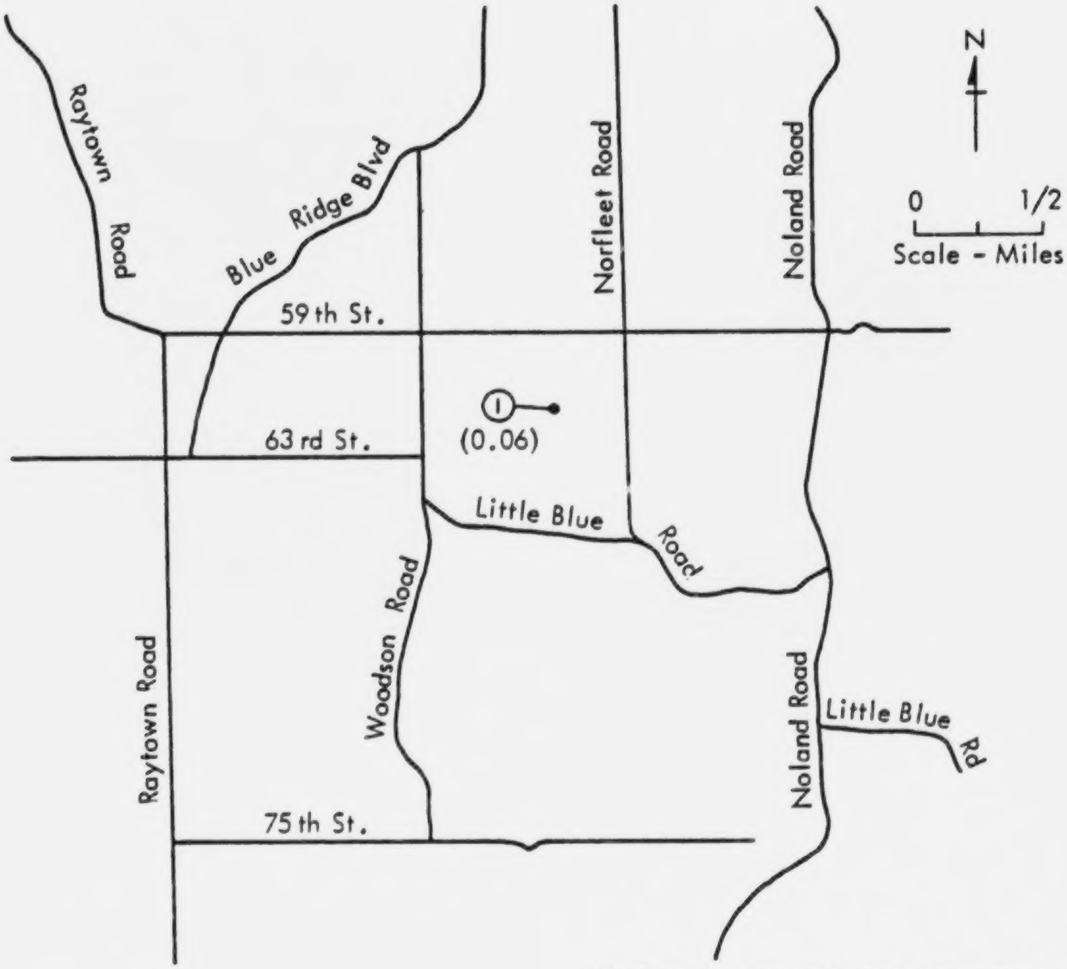
RURAL SITE, MARYVILLE, MISSOURI

Field sampling was conducted at the rural site, located 20 miles northeast of Maryville, Missouri. Four air samples (2 filters and 2 charcoal traps) were collected.

Air Samples

Two air sampling stations were placed adjacent to each other in a field on the farm owned by Mrs. M. Cobb. No retail gasoline stations were within 2 miles. The nearest state highway was 5 miles away.

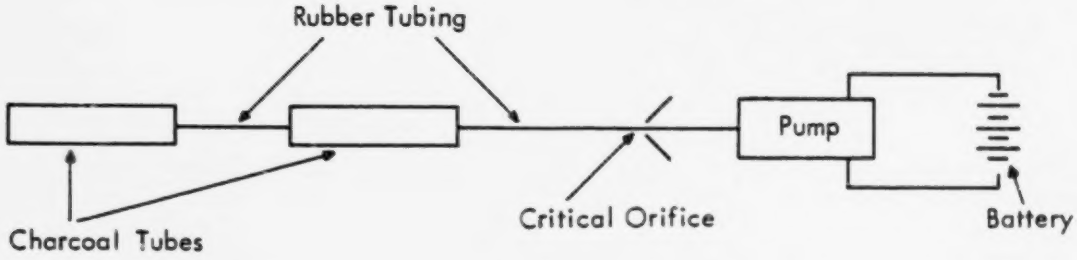
During the sampling period the weather was fair with gusty winds from the south to southwest. The area was sampled to establish a baseline air level of EDB at a location far from any known sources. A duplicate air sample was taken using a modified train to establish that the filter and rubber


Raytown Road
Blue Ridge Blvd
Norfleet Road
Noland Road
N
0
1/2
Scale - Miles
59th St.
63rd St.
1
(0.06)
Little Blue Road
Woodson Road
Raytown Road
Noland Road
Little Blue Rd
75th St.

Number in Parenthesis Represents Average Concentration ($\mu g/m^3$) of EDB

Figure 21. Average concentration of EDB at one sampling station at the suburban site, Kansas City, Missouri.

tubing components of the sampling train had no influence on the observed levels of EDB. The sampling train for sample No. 2 was rearragned into the following configuration.



Levels of EDB: The analytical data for the rural site are shown in Table B-9, and the location of the site is marked in Figure 22. The concentration of 0.07 $\mu g/m^3$ represents the baseline level of EDB in air. The agreement of the two samples shows that the filter and rubber hose components of the sampling train have no effect on the levels of EDB.

Summary

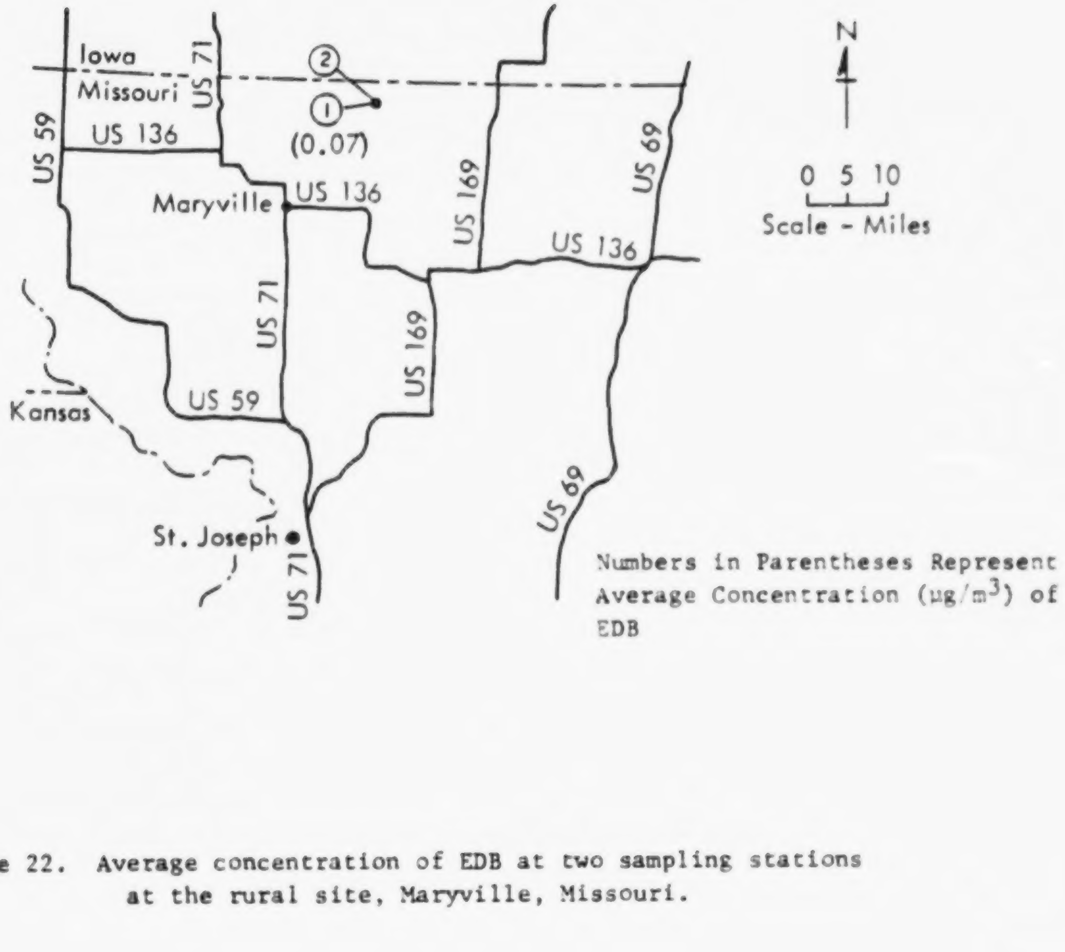
A level of 0.07 $\mu g/m^3$ was observed as a baseline value of EDB in rural unpolluted air. Duplicate samples gave identical results. The sampling train components were shown to have no effect upon the results.

STATE OF FLORIDA - USDA FUMIGATION CENTER, WAHNETA, FLORIDA

Field sampling was performed May 4, 1976, at the State of Florida - USDA Fumigation Center near Wahneta, Florida. A total of 58 air samples (35 charcoal and 23 filter), 9 soil samples, and 9 dustfall samples were collected. No water samples were collected.

Air Samples

The 58 air samples were collected at 17 sampling stations placed generally north, east, and west of the center. Four stations were north, two stations were south, six stations were east and southeast, three stations were west and southwest, and two stations were located inside the fumigation center. One of these stations was located in the adjacent office building near the door while the other station was near the center of the corridor separating the fumigation chambers. Six additional samplers were operated parallel to the four samplers at the facility boundaries and the two samplers inside the facility. The first 17 samplers were operated continuously for 14 hr. The second set of six samplers was operated intermittently through the day to collect short-term samples. During the sampling period, the wind was from the north initially and shifted to the northeast in the evening.


Iowa
Missouri
US 71
②
①
(0.07)
US 59
US 136
Maryville
US 136
US 169
US 69
US 136
US 71
US 169
US 59
Kansas
St. Joseph
US 71
US 69
N
0 5 10
Scale - Miles

Numbers in Parentheses Represent Average Concentration ($\mu g/m^3$) of EDB

Figure 22. Average concentration of EDB at two sampling stations at the rural site, Maryville, Missouri.

Wind rose patterns shown in Figure 23 illustrate the changes. The sampling strategy at this site was expanded to include a determination of what fumigation activities were responsible for EDB emissions.

Geographical Distribution: The analytical data for the air samples are shown in Figures 24 and 25, and are listed in Table B-10. Figure 24 shows the average EDB concentrations in air at the off-site stations and Figure 25 gives the levels for the on-site stations and for the short-term samplers. The long-term levels away from the fumigation center ranged from 29.1 $\mu g/m^3$ at 1/8 mile south to 0.093 $\mu g/m^3$ at 1/2 mile east-southeast. The sample at the southern boundary was expected to be higher than 29 $\mu g/m^3$; however, it was lost. The EDB level at the site farthest downwind (1/2 mile west southwest) was 0.55 $\mu g/m^3$ compared to 0.1 to 0.15 $\mu g/m^3$ for upwind samples. This indicates that, under relatively constant meteorological conditions, EDB levels above background extend out to at least 1/2 mile from the point source. EDB was found in the air at all stations ranging out to 3/4 mile from the fumigation center.

The 13-hr averages of the two additional stations located on-site within the center are shown in Figure 25. The levels of 3,100 and 829 $\mu g/m^3$ found in the office and corridor, respectively, represent the average exposure level within the working area.

Sources of EDB Emissions: The air sampling stations Nos. 5, 6, 13, 14, and 15 were downwind of the center during some part of the day. The EDB levels at these stations, from 0.5 to 29 $\mu g/m^3$, were much higher than the upwind levels of 0.1 to 0.15 $\mu g/m^3$. The elevated levels of EDB are due at least in part to the direct release of EDB from the chambers during the evacuation cycle. The possibility of emissions occurring in other parts of the fumigation cycle was tested by taking short-term samples. The average levels of EDB for the 13-hr sampling period and for the three short-term sampling periods at the six sites are shown in Figure 25. The changes in the EDB levels at these six sites are graphed in Figure 26 A graph of the type of fumigation actively occurring during each of the ampling periods is given in Figure 27. During the first sampling period, fumigation only was occurring in three chambers. The EDB air concentration was 16.7 $\mu g/m^3$ at the downwind site No. 6. The level at the three other sites ranged from nondetectable to 0.15 $\mu g/m^3$. During the second sampling period, two chambers were being evacuated and one chamber was in use for fumigation. EDB at the southern boundary downwind site No. 6 rose to 86.4 $\mu g/m^3$ while the other three sites were 0.35 to 3.3 $\mu g/m^3$. In the third period, the highest level, 29.3 $\mu g/m^3$, was found at the west boundary site No. 15. Again, two chambers were being evacuated while one was sealed for fumigation. As can be seen from Figure 23, the wind had shifted from the north to the northeast. The change in concentrations at the downwind sites shows that the first evacuation caused marked elevation of the EDB levels.

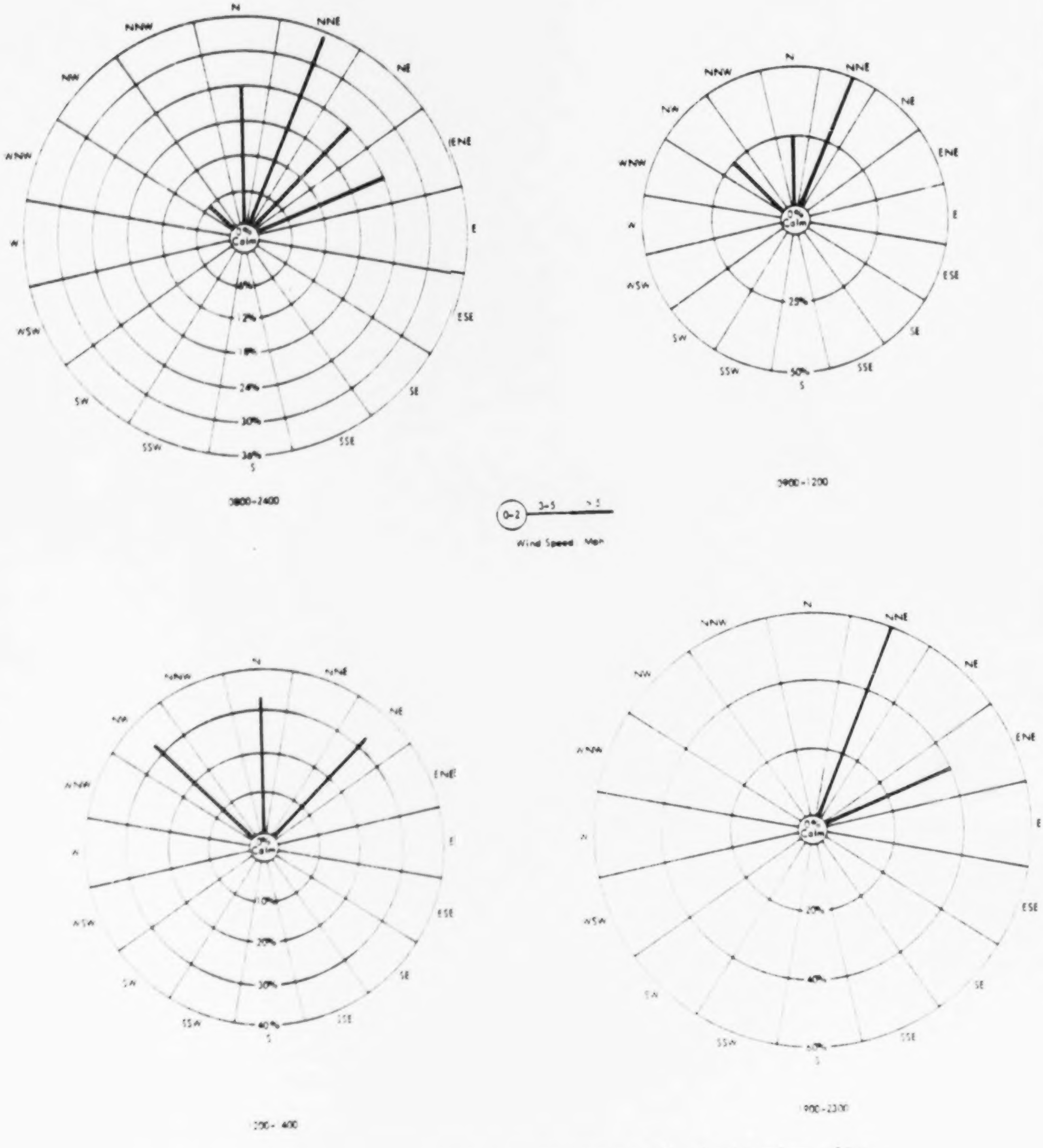


Figure 23. Wind patterns during sampling at the fumigation site, Wahneta, Florida.

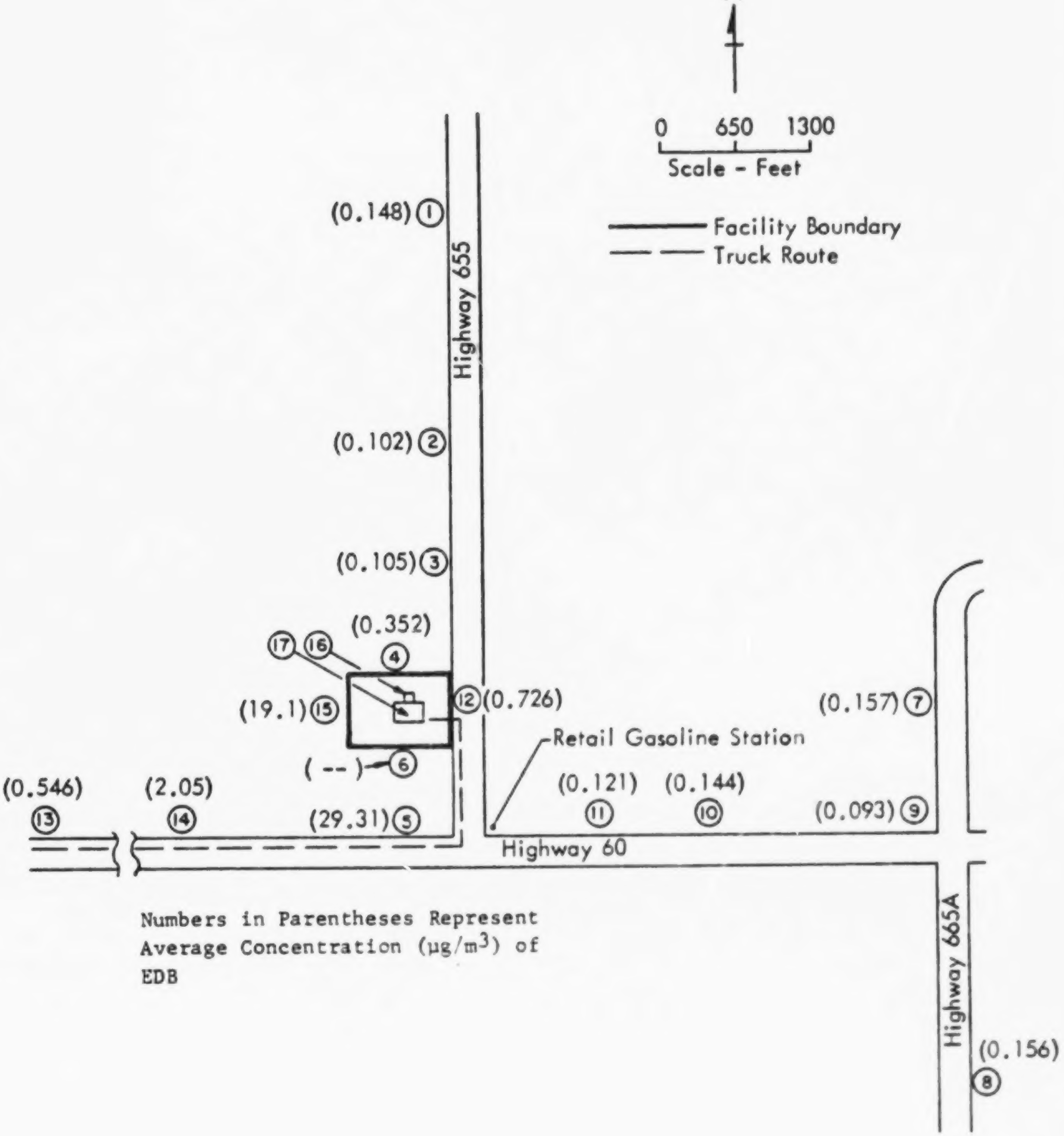

N
0
650
1300
Scale - Feet
Facility Boundary
Truck Route
Highway 655
(0.148) ①
(0.102) ②
(0.105) ③
(0.352)
④
⑰ ⑯
(19.1) ⑮
⑫ (0.726)
(--) ⑥
(0.546)
⑬
(2.05)
⑭
(29.31) ⑤
Retail Gasoline Station
(0.121)
⑪
(0.144)
⑩
(0.157) ⑦
(0.093) ⑨
Highway 60
Highway 665A
(0.156)
⑧
Numbers in Parentheses Represent Average Concentration (µg/m³) of EDB

Figure 24. Average concentration of EDB at the off-site sampling stations at the fumigation site, Wahneta, Florida.

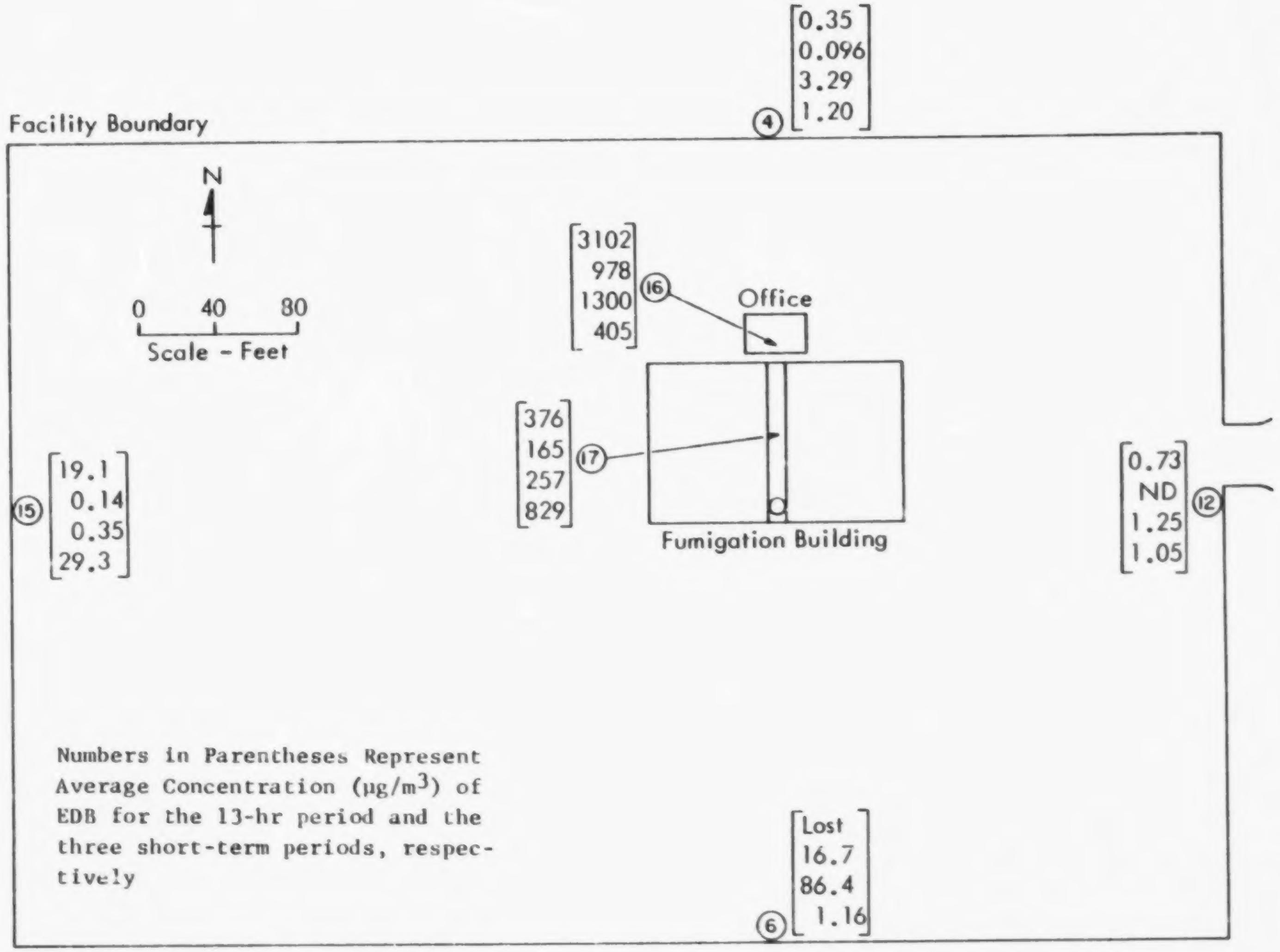

0.35
0.096
3.29
1.20
④
Facility Boundary
N
0
40
80
Scale - Feet
3102
978
1300
405
⑯
Office
376
165
257
829
⑰
Fumigation Building
⑮
19.1
0.14
0.35
29.3
0.73
ND
1.25
1.05
⑫
Numbers in Parentheses Represent Average Concentration (µg/m3) of EDB for the 13-hr period and the three short-term periods, respectively
Lost
16.7
86.4
1.16
⑥

Figure 25. Average concentration of EDB at the on-site sampling stations at the fumigation site, Wahneta, Florida.

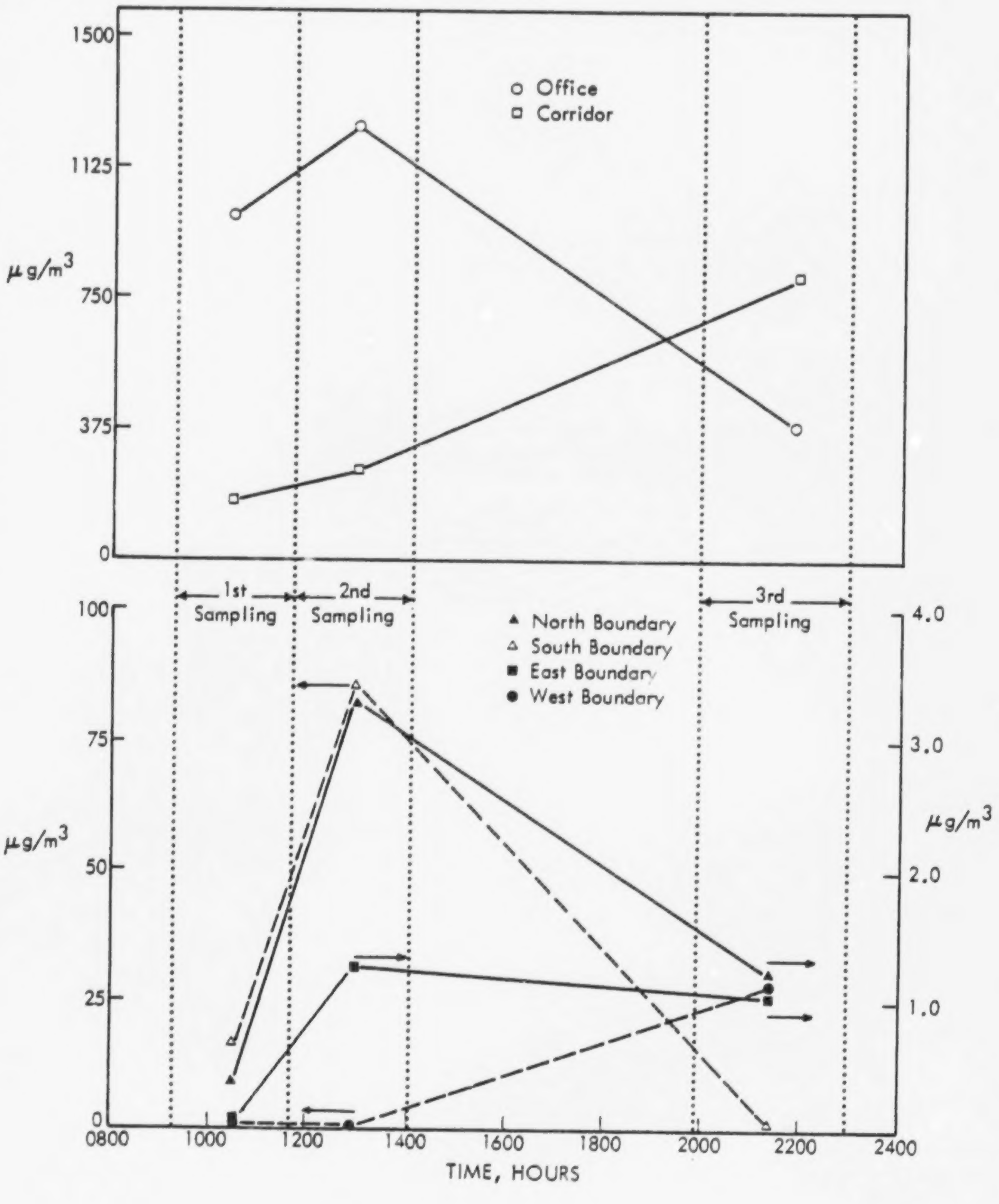


Figure 26. Variation in EDB concentration at six on-site sampling stations at the fumigation site, Wahneta, Florida.

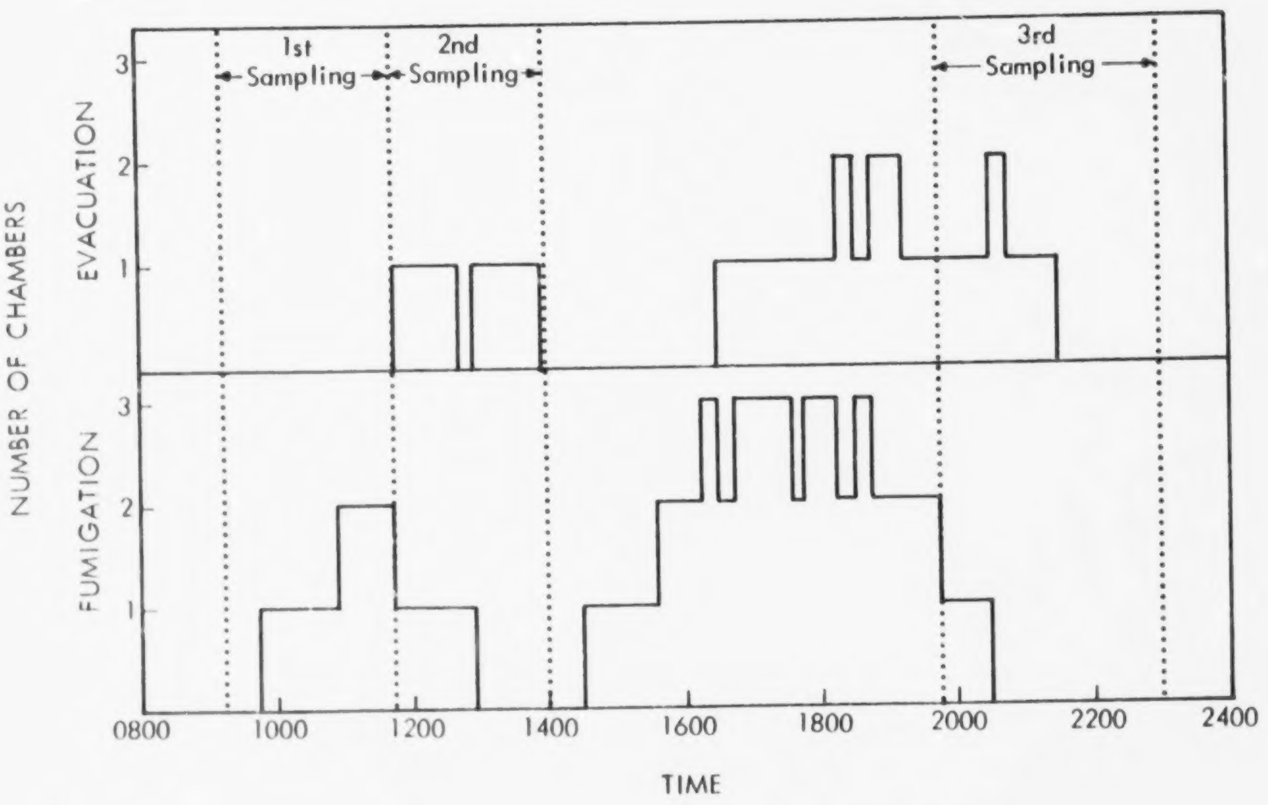


Figure 27. Fumigation activities during sampling at the fumigation site, Wahneta, Florida.

The high level of 16.7 µg/m^3 found at site No. 6 during the fumigation stage, however, indicates that either EDB is being lost during the fumigation stage or that the entire facility itself is a source. The latter could result from an overnight buildup of EDB within the closed facility, which is then released when the facility doors, etc., are opened in the morning. The levels found in the office and the corridor during the first period, 978 and 175 µg/m^3, respectively, strongly suggest an overnight buildup. During the evacuation phase when the second short-term samples were collected, the levels at both building sites rose to 1,300 and 257 µg/m^3, respectively. This indicates that the ventilation system does not remove the EDB from the facility. The air level continued to build within the corridor to 829 µg/m^3 during the third sampling while it dropped to 405 µg/m^3 in the office. The 13-hr average level of 3,102 µg/m^3 at the office station is higher than any of the short-term levels. This could be due to some event occurring during the time when the short-term samples were not being collected. Since the barrel from which EDB is dispensed was located directly outside the door to the office, a spill or a similar activity could have led to a very high but localized level of EDB for a short time. It is not known when EDB was withdrawn from the barrel.

The 13-hr average level at station No. 12 by the exit driveway from the center was 0.73 µg/m^3. This level is higher than would be expected for a site that was constantly upwind or crosswind of the suspected source. A possible explanation is that EDB condenses on the trailers during fumigation and then evaporates from them as they leave the facility. Station No. 12 was by the exit of the center and downwind of the exiting trucks.

Physical Form of EDB

EDB was found on six of the long-term filter samples, although never at significant levels. The highest level, 0.57 µg/m^3, found in the office, was only 0.02% of the vapor level. No relationship of geographic location and particulate level was evident.

Soil Samples

The results of the soil analysis are given in Table 4. EDB was found in all nine soil samples, ranging from 22.6 ng/g immediately south of the center to 0.1 ng/g at 1/2 mile east. The highest level was from the site directly downwind of the center. Soil levels at the other sites at the boundaries ranged from 1.1 to 1.6 ng/g.

Dustfall Samples

As seen from Table 5, EDB was detected in eight dustfall samples. Sample D-6 from air sampling station No. 11 was lost. The dustfall rate ranged from 6 to 65 pg/cm^2/hr. No trend in the levels could be determined.

Table 4. EDB CONCENTRATIONS IN SOIL FROM THE FUMIGATION CENTER, WAHNETA, FLORIDA

Soil sample number and location	Concentration of EDB (ng/g)
S-1, north, 1/8 mile	0.5
S-2, north, 0 mile	1.6
S-3, south, 1/8 mile	0.5
S-4, south, 0 mile	22.6
S-5, east, 1/2 mile	0.1
S-6, southeast, 1/8 mile	0.6
S-7, east, 0 mile	1.1
S-8, southwest, 1/4 mile	0.8
S-9, west, 0 mile	1.2

Table 5. EDB DUSTFALL LEVELS AT THE FUMIGATION CENTER, WAHNETA, FLORIDA

Dustfall sample number and location	Sampling time	ng	Dustfall rate ($pg/cm^2/hr$)
D-1, north, 1/8 mile	0740-2117	8	12
D-2, north, 0 mile	0830-2302	16	22
D-3, south, 1/8 mile	0900-2158	8	12
D-4, south, 0 mile	0849-2315	12	16
D-5, east, 1/2 mile	0750-2131	4	6
D-7, east, 0 mile	0810-2320	8	10
D-8, southwest, 1/4 mile	0850-2200	43	65
D-9, west, 0 mile	0835-2308	40	55

Summary

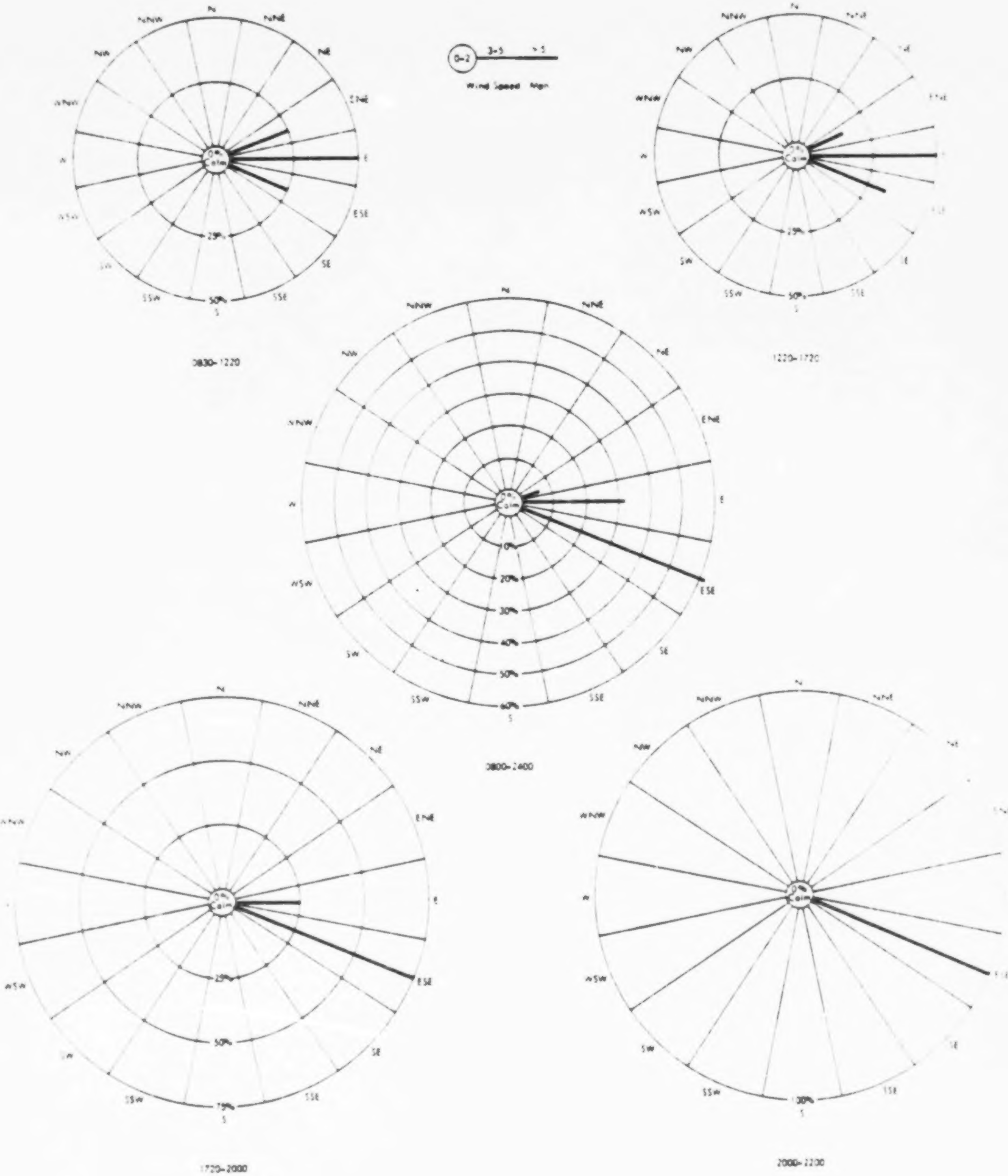
The results of the analysis of the air samples indicate that the fumigation center is a significant source of EDB emissions. The evacuation stage of the fumigation process is the major source of emission. However, downwind samples had elevated levels of EDB before evacuation of any chambers had commenced. The entire facility was functioning as a source of emission. A probable explanation is that the level of EDB inside the buildings builds up during the night and then is released in the morning when the facility is opened. Very high levels of EDB were found in the morning in the office and corridor. The highest levels found, 3,102 and 829 $\mu g/m^3$, were in the office and corridor, respectively. The level of EDB at the exit to the center was slightly elevated even though it was up- and crosswind of the center during sampling. This indicates that the truck trailers after fumigation are acting as mobile sources of emission, resulting from evaporation of EDB condensed on the trailer surfaces. EDB was predominantly present in the air samples as a vapor although particulate EDB was detected. No relationship with vapor levels was evident. EDB was present in all soil samples. The highest level was found downwind of the center. All dustfall samples had detectable levels of EDB although no trend in the levels could be determined.

STATE OF FLORIDA - USDA FUMIGATION CENTER, FT. PIERCE, FLORIDA

Field sampling of the State of Florida - USDA Fumigation Center, Ft. Pierce, Florida, was conducted on May 6, 1976. Sixty-three air samples (41 charcoal and 22 filters), 6 soil samples, 6 dustfall samples, 4 rainfall samples, and 1 runoff water sample were collected.

Air Samples

The 63 air samples were collected at 17 stations located in all directions around the fumigation center. Two stations were north to northeast, two were south to southeast, two were east, seven were west to west-northwest and two were south-southwest of the center. Four of the stations were on the boundary of the center. The two additional stations were in the adjacent office building and in the central corridor separating the banks of fumigation chambers. Five more samplers were positioned and operated in parallel to the five samplers placed at the north, south and west boundaries and in the office and central corridor. The first 17 samplers were operated continuously for 14 hr. The second set of five samplers was used to collect four short-term samples over the same 14-hr period. During the sampling period, the wind was predominantly from the east during the day and from the east-southeast during the evening hours. Individual and a composite wind rose patterns are shown in Figure 28. In addition to the above, two air



0830-1220

1220-1720

0800-2400

1720-2000

2000-2200

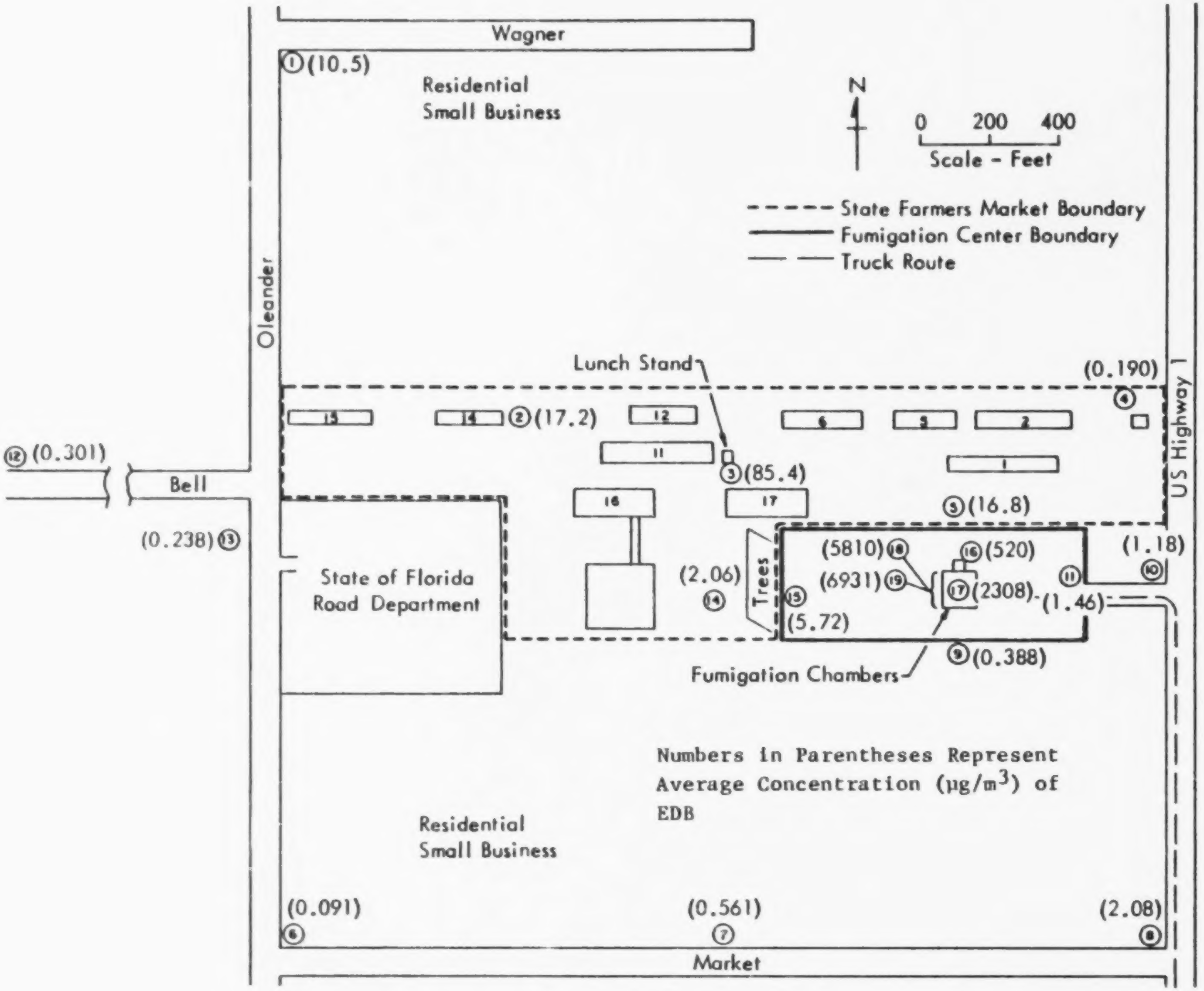
Figure 28. Wind patterns during sampling at the fumigation site, Ft. Pierce, Florida.

samples were collected by the use of personnel samplers attached to two employees. The sampling strategy was modified to include a determination of (a) what fumigation activities were responsible for EDB emissions and (b) the EDB level in the breathing zone air of the facility employees.

Geographical Distribution: The analytical data for the air samples are listed in Table B-11 and shown in Figures 29 and 30. Figure 29 shows the 14-hr averages for the off-site stations and Figure 30 gives the averages for the on-site stations, the short-term samples and for the personnel samples. The 14-hr average EDB air levels, off-site, ranged from 85.4 µg/m^3 at 1/8 mile northwest to 0.091 µg/m^3 at 1/2 mile southwest. The air level at the farthest downwind station, 1 mile west, was 0.31 µg/m^3 compared to background levels of 0.09 to 0.19 µg/m^3. Under the relatively constant wind patterns that existed during the sampling, the EDB emission from the fumigation center could be detected as far away as 1 mile downwind. EDB was found at all sampling stations. The 14-hr averages in the office and corridor, shown in Figure 29, were 520 and 2,300 µg/m^3, respectively. These values indicate the average exposure within the working area.

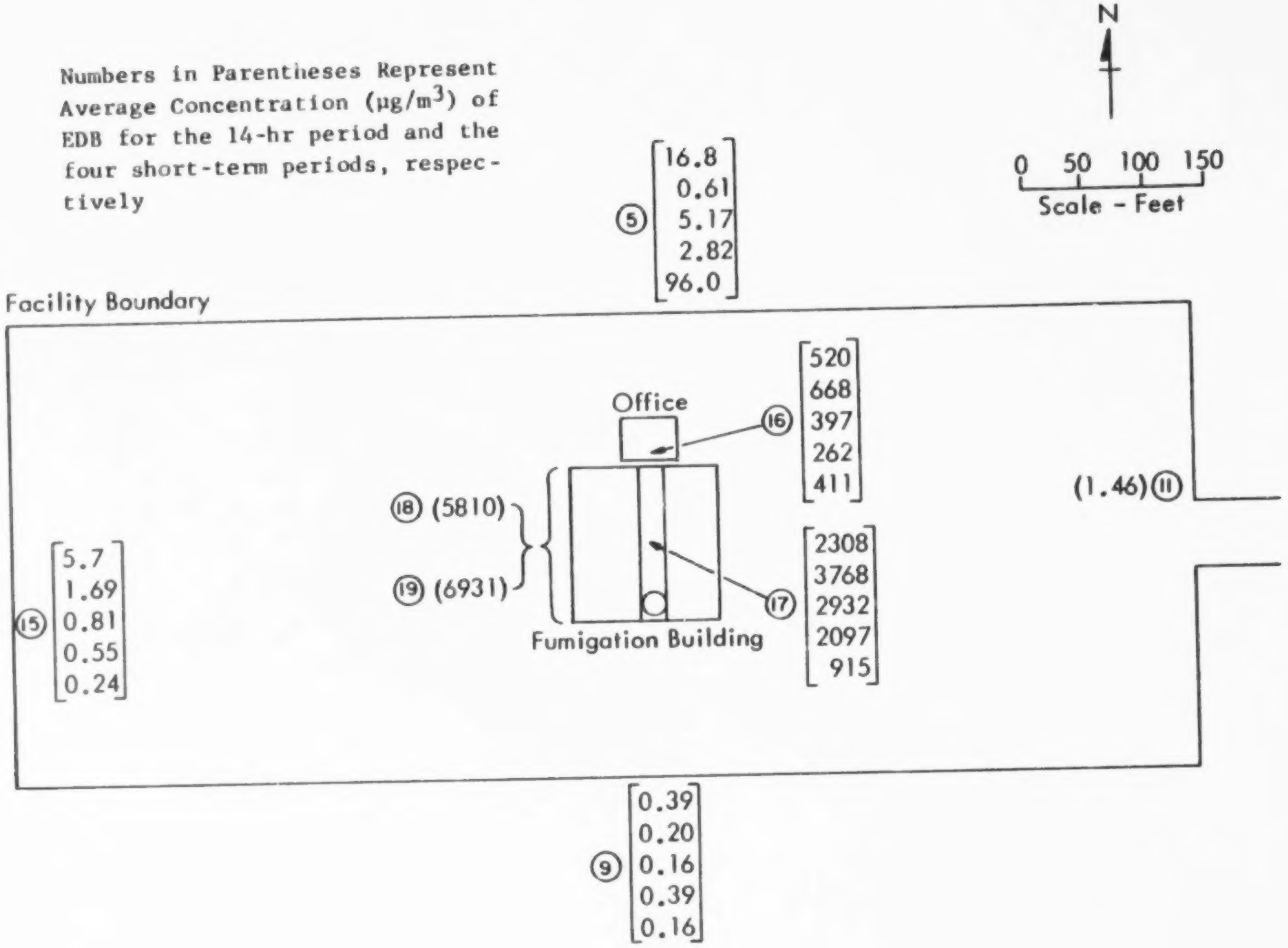
Sources of EDB Emission: The wind patterns, obtained from the Vero Beach airport, indicated that the downwind samplers would be those directly west of the facility. The highest 14-hr average levels, however, were observed for the samplers generally located west-northwest. The level found at the west boundary, 5.7 µg/m^3, compared to that at 1/8 mile northwest, 85.4 µg/m^3, indicates that the direction of the plume was not straight west but northwest. That could have been due in part to the actual wind direction at the site being from the southeast plus microclimatological effects caused by the tree line and buildings directly west of the facility.

The high levels observed to the west-northwest were at least partially a result of the direct release of EDB during the evacuation step. The short-term samples were collected to establish if significant emissions occurred during other parts of the cycle. The EDB levels for four time periods at the five short-term samplers are shown in Figure 30 and graphed in Figure 31. The fumigation activities during each of the sampling periods are shown in Figure 32. During the first sampling period, fumigation was occurring in as many as seven chambers while little evacuation occurred. Significant evacuation then occurred during each of the next three periods. The greatest changes in EDB levels occurred at the north boundary station. The differences between the first period and the second, third and fourth periods indicate that evacuation is the major source of emission. By the fourth period, the wind had shifted sufficiently (see Figure 28) so that the north boundary station was more nearly downwind and the level of EDB rose considerably. No significant change occurred at the south boundary site. The level at the west site decreased throughout the day. The EDB concentration at the west and north stations in the first period was higher than the upwind sites.


Wagner
①(10.5)
Residential
Small Business
N
0 200 400
Scale - Feet
State Farmers Market Boundary
Fumigation Center Boundary
Truck Route
Oleander
Lunch Stand
(0.190)
④
US Highway 1
15
14
②(17.2)
12
6
5
2
11
③(85.4)
1
⑫(0.301)
Bell
16
17
⑤(16.8)
(0.238)⑬
State of Florida
Road Department
(2.06)
⑭
Trees
⑮
(5.72)
(5810)⑱
(6931)⑲
⑯(520)
⑰(2308)
⑪
(1.46)
(1.18)
⑩
⑨(0.388)
Fumigation Chambers
Residential
Small Business
(0.091)
⑥
(0.561)
⑦
(2.08)
⑧
Market

Numbers in Parentheses Represent Average Concentration (μg/m^3) of EDB

Figure 29. Average concentration of EDB at the off-site sampling stations at the fumigation site, Ft. Pierce, Florida.


Numbers in Parentheses Represent Average Concentration (μg/m^3) of EDB for the 14-hr period and the four short-term periods, respectively

N
0 50 100 150
Scale - Feet
Facility Boundary
⑤ 16.8 0.61 5.17 2.82 96.0
Office
⑯ 520 668 397 262 411
⑰ 2308 3768 2932 2097 915
⑱ (5810)
⑲ (6931)
Fumigation Building
(1.46) ⑪
⑮ 5.7 1.69 0.81 0.55 0.24
⑨ 0.39 0.20 0.16 0.39 0.16

Figure 30. Average concentration of EDB at the on-site sampling stations at the fumigation site, Ft. Pierce, Florida.

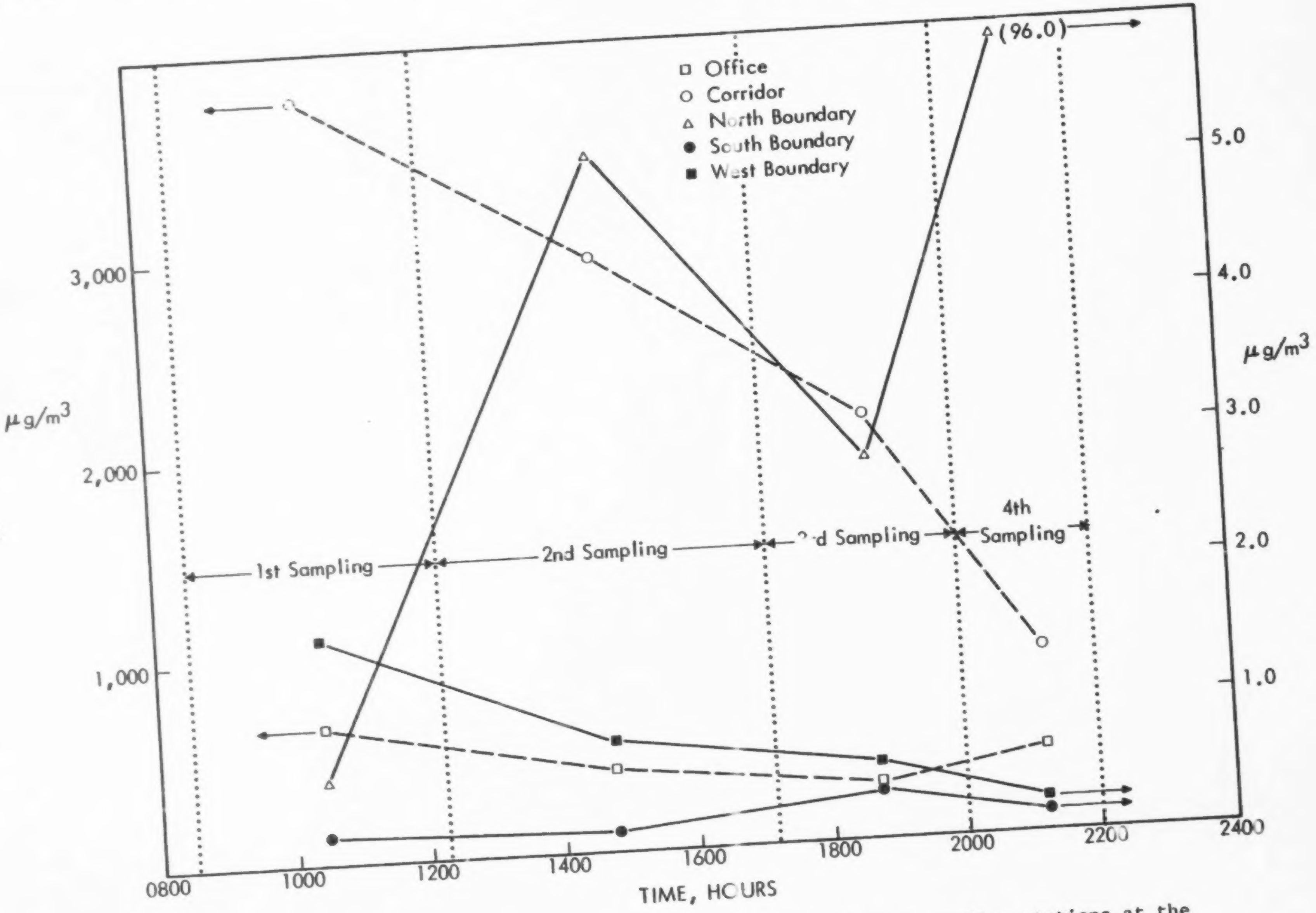


Figure 31. Variation in EDB concentration at five on-site sampling stations at the fumigation site, Ft. Pierce, Florida.

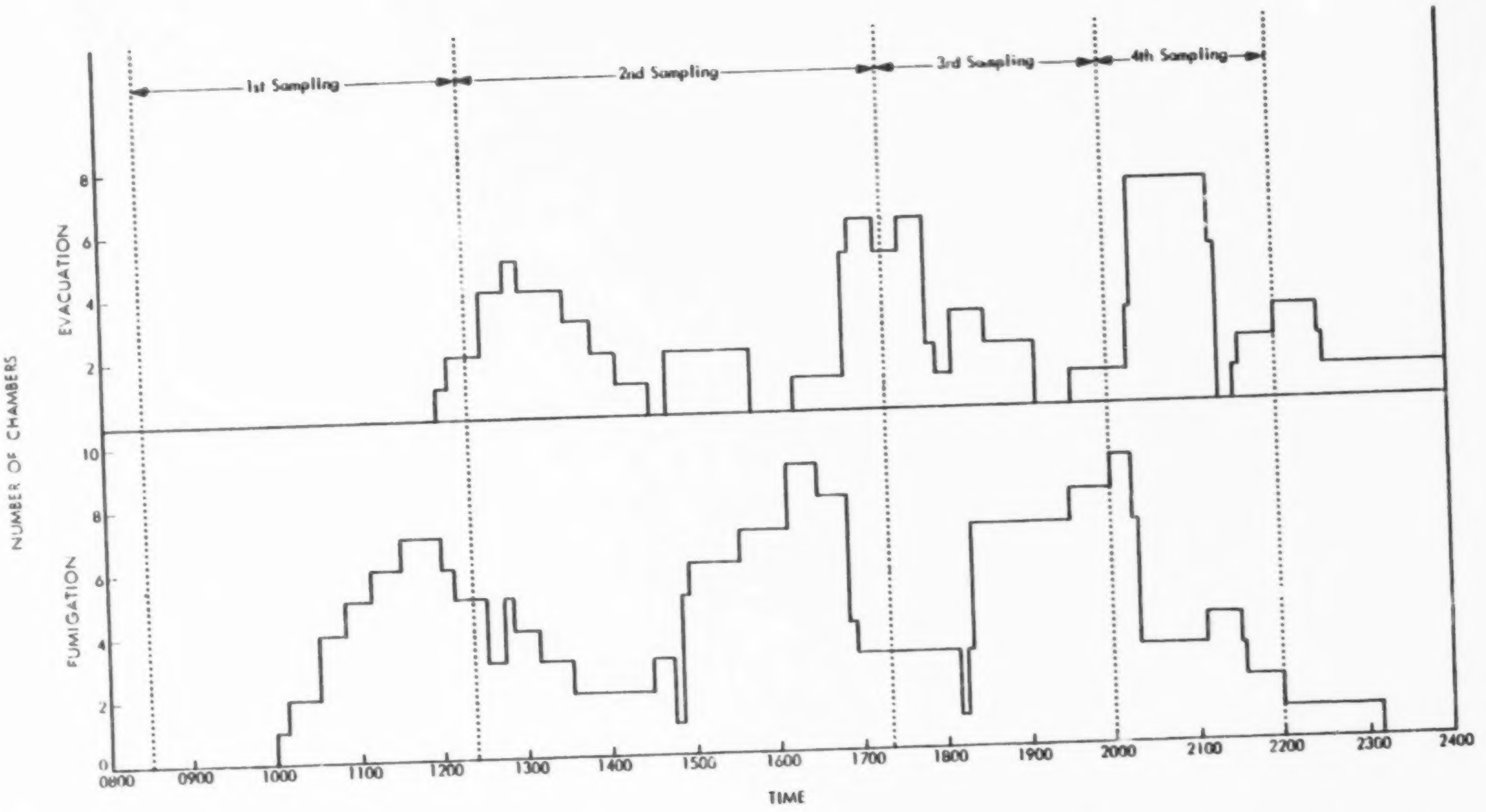


Figure 32. Fumigation activities during sampling at the fumigation site, Ft. Pierce, Florida.

This again indicates either loss of EDB from the fumigation chambers in use or that the entire facility is a source. The latter could be a consequence of an overnight buildup of EDB within the facility which was released as the buildings were opened. This is supported by the high levels found in the corridor and office, 3,770 and 668 µg/m^3, respectively, during the first sampling period. These levels tended to decrease during the day despite the extensive fumigation activities. The 14-hr average levels in the office and corridor of 520 and 2,300 µg/m^3 agree well with the four short-term levels.

The slightly elevated levels of EDB at the east, southeast and southwest sites suggest that the truck trailers are sources of EDB emissions. The levels of 1.5 and 1.2 µg/m^3 at the two eastern sites along the driveway are higher than the downwind level of 0.19 µg/m^3 at site No. 4. Furthermore, the EDB levels of 0.56 and 2.08 µg/m^3 at sites Nos. 7 and 8, southeast and southwest of the center, also are elevated. These sites were never downwind of the fumigation center but were downwind of the route used by the trucks which had been fumigated. The decrease in levels from east to west along Market Street is as expected if the trailers were indeed sources.

Breathing Zone Levels of EDB: Personnel samplers were used on two different employees for 4.0- and 3.3-hr periods, respectively. During each of those time periods, 10 fumigations were started and 10 evacuations were completed. An employee entered a chamber on each one of these occasions. Since several employees were working, it was not known how many times the individual wearing the sampler actually entered the chambers. The EDB levels in the breathing zone air was 5,810 and 6,930 µg/m^3 for the two sampling periods.

Physical Form of EDB

EDB was found on 15 of the long-term filter samples, although never in significant concentrations. At only three sites was the EDB particulate concentration greater than 10% of the air level. Those sites, Nos. 6, 10, and 12, all showed total EDB air levels of less than 2 µg/m^3. Figure 33 shows the relationship between the vapor and particulate levels of EDB at the six closest sites. No distinct trend can be seen.

Soil Samples

The results of the soil sample analysis are shown in Table 6. All six samples contained detectable levels of EDB. The levels ranged from 3.4 ppb (ng/g) at 1/8 mile west to 0.4 ppb at the east boundary. No strong correlation between level and position was evident although generally the nearest sites downwind had high levels.

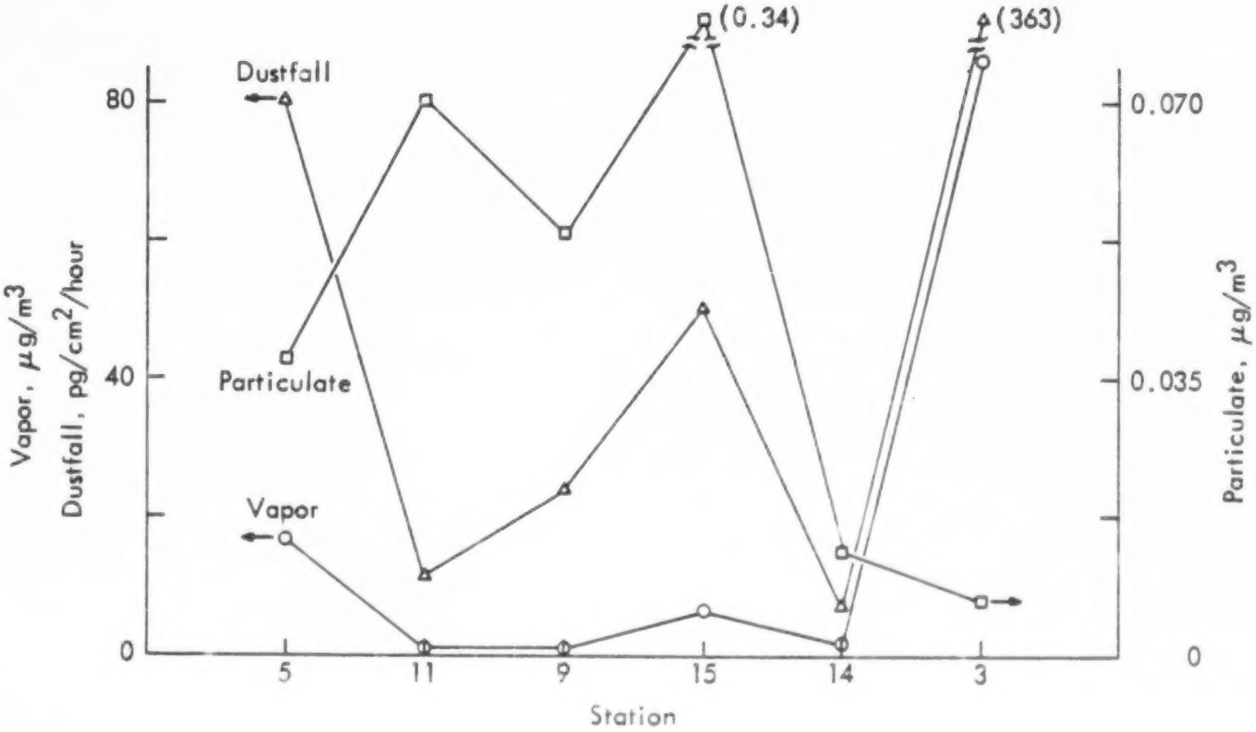


Figure 33. Vapor, particulate and dustfall levels of EDB at six sampling stations at the fumigation site, Ft. Pierce, Florida.

Table 6. EDB CONCENTRATIONS IN SOIL FROM THE FUMIGATION CENTER, FT. PIERCE, FLORIDA

Soil sample number and location	Concentration of EDB (ng/g)
S-1, northwest, 1/8 mile	0.5
S-2, north, 0 mile	1.2
S-3, south, 0 mile	0.8
S-4, east, 0 mile	0.4
S-5, west, 1/8 mile	3.4
S-6, west, 0 mile	0.8

Dustfall Samples

A list of the results from analysis of the dustfall samples is given in Table 7. The rates varied from a high of 363 pg/cm^2/hr at 1/8 mile west-northwest to a low of 6 pg/cm^2/hr at 1/8 mile west. The relationships between dustfall rate and the vapor and particulate levels of EDB are shown in Figure 33. The dustfall rates correlate well with the vapor concentration but do not correlate with the particulate concentration. A probable explanation is that the EDB trapped as particulate evaporates during the air sampling and is ultimately trapped by the charcoal tubes. This would give erradic results for particulate EDB.

Table 7. EDB DUSTFALL LEVELS AT THE FUMIGATION CENTER, FT. PIERCE, FLORIDA

Dustfall sample number and location	Sampling time	ng	Dustfall rate (pg/cm^2/hr)
D-1, northwest 1/8 mile	0930-2229	236	363
D-2, north, 0 mile	0830-2210	55	80
D-3, south, 0 mile	0920-2220	8	12
D-4, east, 0 mile	0914-2215	16	24
D-5, west, 1/8 mile	0925-2233	4	6
D-6, west, 0 mile	0937-2225	32	50

Rainfall and Runoff Water Samples

The results of the analyses of the five rainfall and runoff water samples are presented in Table 8. The rainfall samples were between 0.9 and 1.1 µg/liter and the runoff water was only slightly higher at 2.0 µg/liter.

Table 8. EDB CONCENTRATIONS IN RAINFALL[a/] AND RUNOFF WATER AT THE FUMIGATION CENTER, FT. PIERCE, FLORIDA

Sample number and location	Type	Volume collected	ng	µg/ℓ
W-1, north, 0 mile	Rainfall	14 ml	15	1.1
W-2, south, 0 mile	Rainfall	14 ml	13	0.9
W-3, east, 0 mile	Rainfall	14 ml	12	0.9
W-4, west, 0 mile	Rainfall	14 ml	15	1.1
W-5, west, 0 mile	Runoff	200 ml	402	2.0

---

a/ Rainfall was 0.1 in.

Summary

The results of analysis of the air samples show that the center is a source of EDB emission. The level of EDB was elevated as far away as 1 mile downwind of the facility. The evacuation phase of the fumigation process was the major source of emission; however, the facility showed elevated levels of EDB in the morning hours prior to the evacuation of any chambers. This indicates that the center itself is a source. This may result from the release of EDB from the interior of the buildings when the facility is opened in the mornings. The levels of EDB in the office and corridor, 668 and 3,770 µg/m^3, respectively, before any evacuations, demonstrate that high levels build up overnight. The elevated levels of EDB seen at the sites by the exit and upwind of the fumigation center along the truck route indicate that the trucks, after fumigation, may function as temporary mobile sources of EDB emissions. Personnel samplers, placed on employees who were working in the chambers and the corridor, showed that their exposure level was from 5,800 to 6,930 µg/m^3 (0.75 to 0.90 ppm). While some particulate EDB was found, the predominant form was vaporous. EDB was found in all six soil samples collected. No definite correlation between position and level was evident although the nearest sites downwind generally had higher levels. All six dustfall samples were found to contain EDB. The dustfall rate correlates with the air vapor levels of EDB but not with the particulate levels. Levels of 0.9 to 1.1 μg/liter EDB were found in four rainfall samples. The runoff water sample had twice that value.

SECTION VI

SUMMARY AND CONCLUSIONS

SUMMARY

A summary of the results is given in Table 9. The high and low concentrations of EDB are listed for each of the sampling sites along with the probable sources.

Air samples collected near the four different bulk loading stations had EDB levels at least twice that of the upwind samples. The levels at the bulk loading stations ranged from 0.13 to 0.20 $\mu g/m^3$ of EDB. The effect of EDB emission from the bulk loading stations was not discernible beyond 1/8 mile. The air concentration of EDB near the pipeline pumping stations, lead mix blending facilities, lead mix storage areas, and leaded gasoline storage areas was not greater than the upwind or baseline levels.

Air samples were collected near clusters of three and five retail gasoline stations in two cities. The concentration of EDB in the air, from 0.18 to 0.50 $\mu g/m^3$, was 2 to 2-1/2 times greater than the concentration at sampling sites 1/8 to 1 mile away. Air samples taken cross- and downwind of two retail gasoline stations in a third city did not differ greatly from each other.

Air samples were taken upwind and downwind of a heavily trafficked freeway in two different cities. The level of EDB found in the air next to the freeway was essentially the same as that found 1/8 to 1 mile up- and downwind.

Air samples collected from a low traffic suburban site and a rural site had EDB levels of 0.06 to 0.07 $\mu g/m^3$. These levels are generally in good agreement with the lowest levels found around sites having suspected sources of EDB. Exceptions were the metropolitan areas which had higher baseline levels, e.g., Camden (0.38 $\mu g/m^3$), Phoenix (0.31 $\mu g/m^3$), Los Angeles (0.11 $\mu g/m^3$).

Table 9. DATA SUMMARY FOR PROGRAM TASK IV

Site	Sources	Air (µg/m^3)		Soil (ng/g)		Dustfall (pg/cm^2/hr)		Water (µg/ℓ)	
		High	Low	High	Low	High	Low	High	Low
Continental Oil Company	Lead mix storage	0.131	0.048	N.D.	N.D.	N.D.	N.D.	0.17	0.14
Ponca City, Oklahoma	Lead mix blending								
	Bulk truck loading								
Mobil Oil Company	Lead mix storage	0.201	0.088	N.D.	N.D.	N.D.	N.D.	No sample	
Paulsboro, New Jersey	Lead mix blending								
	Bulk truck loading								
Retail gasoline stations								No sample	
Phoenix, Arizona	Retail gasoline sales	0.503	0.194	No sample		No sample		0.17	0.11
Los Angeles, California	Retail gasoline sales	0.184	0.087	No sample		No sample		No sample	
Camden, New Jersey	Retail gasoline sales	0.49	0.38	No sample		No sample			
Highly trafficked									
Phoenix, Arizona	Vehicular traffic	0.444	0.308	No sample		No sample		No sample	
Los Angeles, California	Vehicular traffic	0.156	0.109	No sample		No sample		No sample	
Suburban									
Kansas City, Missouri	--	0.060	--	No sample		No sample		No sample	
Rural									
Maryville, Missouri	--	0.071	--	No sample		No sample		No sample	
State of Florida - USDA									
Fumigation Center								No sample	
Wahneta, Florida	Fumigation	3,102	0.093	22.6	0.1	65	6	2.0	0.9
Ft. Pierce, Florida	Fumigation	6,931	0.091	3.4	0.4	363	6		

Air samples were collected around two fumigation centers where EDB was being used to fumigate grapefruit for the Caribbean fruit fly. The highest levels of EDB at the downwind sites were found during the time when EDB was being exhausted into the environment from the fumigation chambers. The maximum level found downwind was 96 $\mu g/m^3$. However, levels above background were observed even before any chambers had been purged. EDB levels inside the facility buildings were 40 to 70 times greater than the highest levels found downwind of the sites. The highest level observed, 6,930 $\mu g/m^3$ (0.90 ppm) was found using a personnel sampler placed on an employee. The average level of exposure inside the fumigation center was 370 to 3,100 $\mu g/m^3$. Slightly elevated levels of EDB were found at stations which were not downwind of the facility but were adjacent to or downwind of the route used by the trucks after fumigation.

The extent of the geographical impact of the various sources of EDB was determined. No effect of a cluster of three to five retail gasoline stations could be observed above background beyond 1/8 mile. The effect of the exhausting of EDB from a fumigation center, however, could be observed as far as 1 mile downwind.

EDB found in the air around the oil refineries, the retail gasoline stations, the highly trafficked areas, the suburban and the rural areas was in the vapor form only. Low levels of EDB were found on the particulate fraction of some air samples collected around the fumigation centers.

No EDB was found in the soil around the oil refineries. Low levels of EDB, in the nanogram per gram range, were found in soil close to the fumigation centers.

No EDB was found in the dustfall samples collected near the oil refineries. Dustfall rates of 6 to 363 $pg/cm^2/hr$ EDB were observed in the vicinity of the fumigation facilities. The higher dustfall rates were found at stations having the higher vapor levels.

Very low levels of EDB, less than 0.2 μg/liter, were found in the aqueous effluent stream from one oil refinery. Rainfall runoff water from the area of several retail gasoline stations was found to have less than 0.2 μg/liter EDB. Rainfall samples collected close to a fumigation center had an EDB level of 1 μg/liter. A runoff water sample from the same center contained 2 μg/liter.

CONCLUSIONS

The EDB used in leaded gasoline was found to enter the environment principally from two sources. These were (a) the gasoline truck bulk loading stations and (b) the retail gasoline stations. Areas such as gasoline pipeline pumping stations, lead mix blending facilities, lead mix storage tanks, and leaded gasoline storage tanks were not discernible sources of EDB. Heavily trafficked roadways did not have elevated levels of EDB. However, this does not mean that automobiles are not sources because higher background levels were observed in heavily trafficked metropolitan areas. EDB was also found at suburban and rural sites far removed from any specific sources. This ubiquitous nature of EDB is evidently a result of all gasoline bulk loading stations, retail gasoline stations and possibly the leaded gasoline powered vehicles being highly dispersed sources of emission. The baseline level of EDB in air was 0.05 to 0.10 $\mu g/m^3$ in rural and suburban areas and 0.1 to 0.4 $\mu g/m^3$ in metropolitan areas.

Two fumigation centers using EDB were found to be significant sources of EDB emissions. The exhausting of vaporous EDB from the fumigation chambers was the activity principally responsible for releasing EDB. Levels as high as 96 $\mu g/m^3$ were observed downwind of the facilities. Elevated levels of EDB found before any chambers had been evacuated may be due to the facility itself being a source of emissions. EDB levels as high as 3,100 $\mu g/m^3$ were found within the facility in the morning before any fumigation activities had begun. Elevated levels of EDB along the truck routes indicated that the trucks, after fumigation, were mobile sources of emissions. This would result from evaporation of EDB which had condensed onto the truck during the fumigation process.

The predominant physical form of EDB was as a vapor. Particulate EDB was seldom observed. EDB is moderately volatile and this behavior is expected. This is also in agreement with the fact that very few dustfall samples had even detectable levels of EDB. The low level of EDB in the soil may also be due to its moderate volatility.

The EDB concentration in rainfall and runoff water at a fumigation center (1 to 2 μg/liter) was not significantly greater than the levels found in a refinery effluent (0.1 ug/liter) or a retail gasoline station runoff water (0.2 μg/liter) despite the large differences in air levels. This indicates that rainfall does not efficiently wash out EDB from air.

REFERENCES

1. Going, J. E., "Sampling and Analysis of Selected Toxic Substances. Task II - Ethylene Dibromide," EPA 560/6-75-001, September 1975.

2. Review of Selected Literature on Ethylene Dibromide (EDB), Office of Toxic Substances, Environmental Protection Agency, Washington, D.C., November 1975.

3. Maricopa County Traffic Engineering Department, Phoenix, Arizona.

4. County of Los Angeles, Road Department, Los Angeles, California.

5. City of Camden, Police Department, Camden, New Jersey.

6. "Petroleum Refineries in the United States and Puerto Rico," U.S. Department of the Interior, Bureau of Mines, Washington, D.C., January 1, 1975.

APPENDIX A

PRESAMPLING SITE VISIT AND FIELD SAMPLING

Presampling site visits and field samplings were conducted at the recommended sites according to the schedule shown in Figure A-1. During the presampling visit, the specific location of a potential source was established from discussion with plant personnel or by visual inspection. With this information, plus the general meteorological patterns, the locations of the individual sampling stations were established. Other relevant information, such as automobile traffic data, was collected at that time. Field sampling was conducted within 1 to 3 weeks. Detailed descriptions of the presampling site visits and the field sampling trips are given below.

CONTINENTAL OIL COMPANY, PONCA CITY, OKLAHOMA

PRESAMPLING SITE VISIT

A presampling site visit was conducted March 8, 1976, at the Continental Oil Refinery, Ponca City, Oklahoma. The following plant personnel were present:

Mr. K. C. Hunt	Continental Oil Company
Mr. D. Orrell	Continental Oil Company
Mr. J. Going	MRI

The Conoco Oil Refinery is located at the southwest corner of Ponca City, Oklahoma, outside the city limits. Directly north and east are residential sections of Ponca City. South and west are both rural farming areas. The terrain is notably flat. U.S. Highway 60 runs east-west through the center of the refinery.

The locations of the EDB-related operations are indicated in Figure A-2. Lead mix containing EDB is brought in by railroad car and stored near the blending facility. Blending of gasoline with the lead mix is performed intermittently and the leaded gasoline is then stored in tanks. The leaded gas is transferred bv vacuum into the storage tanks with expansion balloon tanks being used to trap vapors released during loading of the storage tanks. The leaded gasoline is transported out of the refinery by tank truck and by two pipeline companies. The tank truck bulk loading station is located off Highway 60 near the middle of the refinery. The facility uses top-loading with an open stream. Immediately east of the bulk loading station is the Cherokee Pipe Line Company, owned by the Conoco Oil Company.

The Williams Brothers Pipe Line Company is located at the southern boundary of the oil refinery and has a pipeline pumping station and several storage tanks.

	Jan	Feb	Mar	Apr	May
Phoenix, Arizona: Retail Gas Highly Trafficked Urban		△ ☐			
Los Angeles, Calif.: Retail Gas Highly Trafficked Urban		△	☐		
Maryville, Missouri: Rural			☐		
Kansas City, Missouri: Surburban			☐		
Continental Oil Company Ponca City, Oklahoma			△ ☐		
Mobil Oil Company Paulsboro, New Jersey				△ ☐	
Camden, New Jersey Retail Gas				△ ☐	
State of Florida - USDA Fumigation Center, Wahneta, Florida					△☐
State of Florida - USDA Fumigation Center, Ft. Pierce, Florida					△☐

△ Presampling Site Visit
☐ Field Sampling

Figure A-1. Presampling site visit and field sampling schedule.

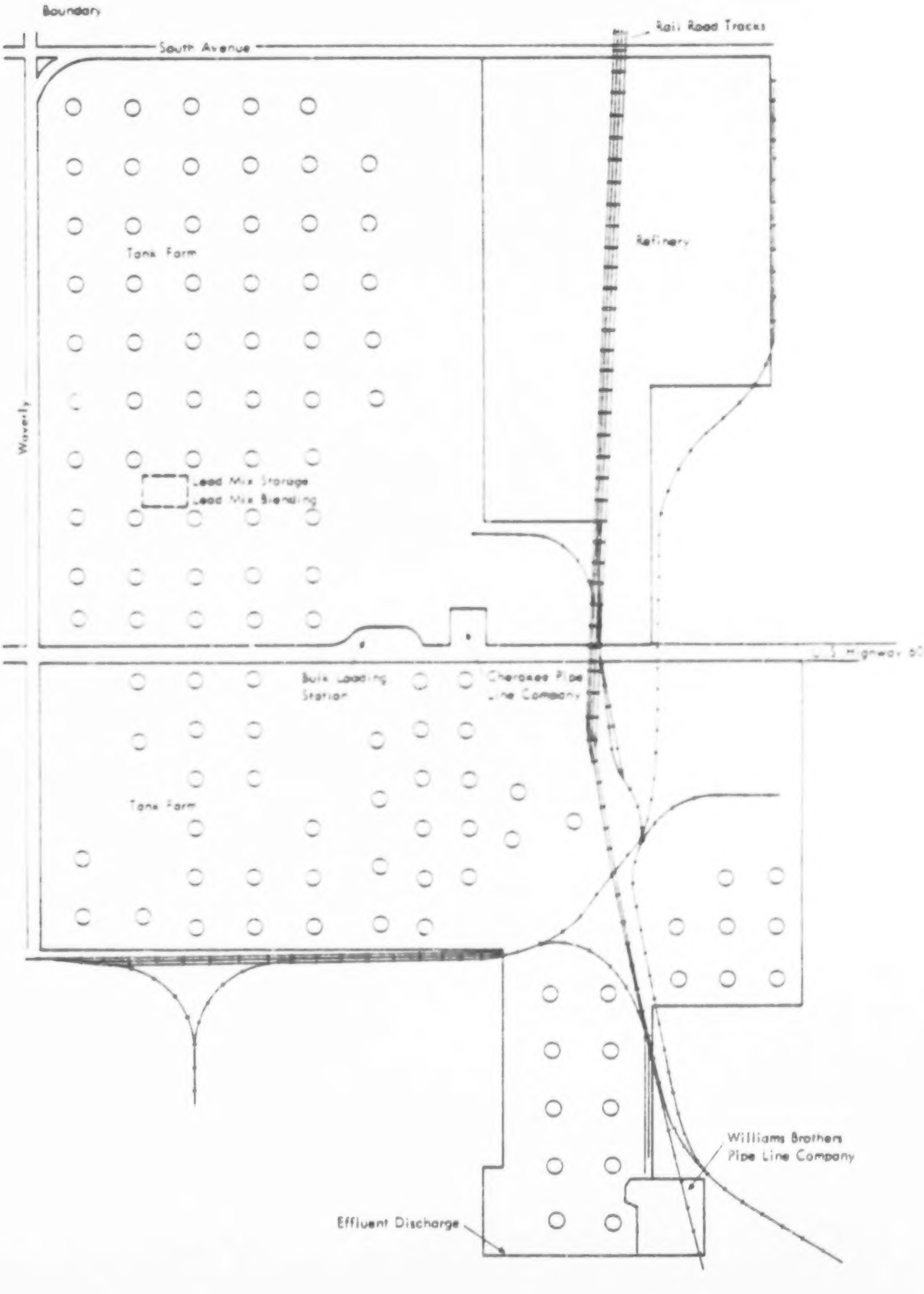

Boundary
South Avenue
Rail Road Tracks
Refinery
Tank Farm
Waverly
Lead Mix Storage
Lead Mix Blending
U.S. Highway 60
Bulk Loading Station
Cherokee Pipe Line Company
Tank Farm
Williams Brothers Pipe Line Company
Effluent Discharge

Figure A-2. Conoco Oil Refinery, Ponca City, Oklahoma.

According to plant personnel, only 3 to 4.5% of the leaded gasoline produced is sold through the bulk loading station. The remainder is sold in roughly equal quantities to the Cherokee and Williams Brothers Pipe Line companies. Wastewater is released from a series of biodegradation ponds at the southern border of the plant. The effluent feeds a small open stream that goes south and would ultimately feed the Salt Fork of the Arkansas River.

FIELD SAMPLING

Field sampling was conducted on March 31, 1976; air, water, soil and dustfall samples were collected. A complete description of the sampling sites, sampling, and meteorological conditions follows.

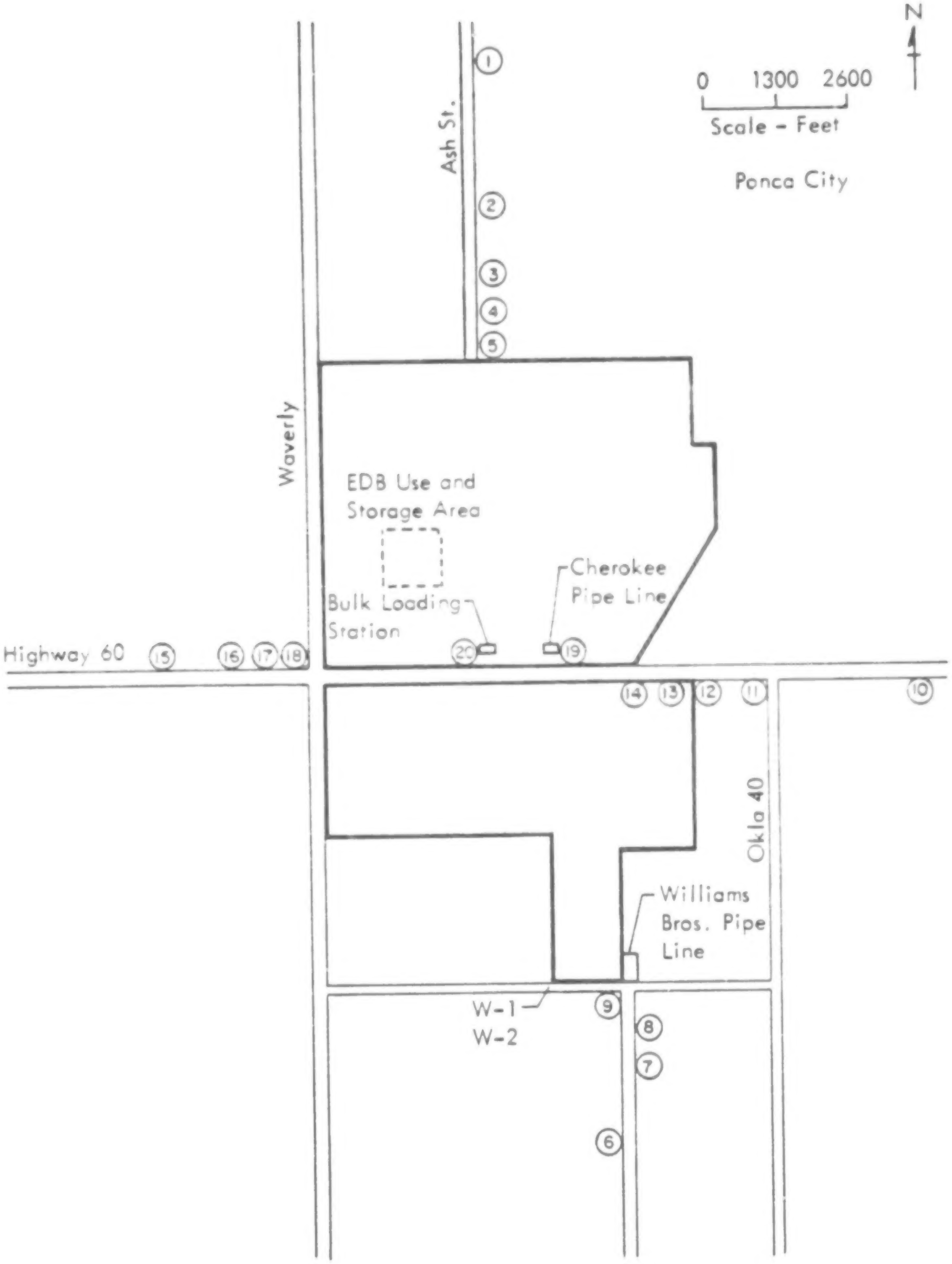
Air Sampling

Eighteen air sampling stations were located along north, south, east, and west transects starting at the plant boundary. The stations were generally located 0, 1/8, 1/4, 1/2, and 1 mile from the fence lines. The north leg extended into residential Ponca City, the east and west legs were on Highway 60, and the south leg extended into a rural area. Two additional sites were located on Highway 60 in the middle of the refinery directly south of the bulk loading station and the Cherokee Pipe Line Company. The south, 0-mile station was immediately south of the Williams Brothers Pipe Line Company. All sampling stations were operated for approximately 18 hr. The locations of all the sampling stations are shown in Figure A-3. The exact locations of the stations, with respect to the plant boundaries, are listed in Table A-1 along with the appropriate sampling data.

Soil Sampling

Soil samples were collected at the following air sampling stations.

S-1
S-2
S-3
S-4
S-5
S-6


N
0 1300 2600
Scale - Feet
Ponca City
Ash St.
Waverly
EDB Use and Storage Area
Bulk Loading Station
Cherokee Pipe Line
Highway 60
Okla 40
Williams Bros. Pipe Line
W-1
W-2
①
②
③
④
⑤
⑥
⑦
⑧
⑨
⑩
⑪
⑫
⑬
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⑮
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⑰
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⑲
⑳

Figure A-3. Sampling locations at the Conoco Oil Refinery.

Table A-1. AIR SAMPLING DATA AT CONOCO OIL COMPANY, PONCA CITY, OKLAHOMA

Area	Sample No.	Exact location	Total sampling time (hr)	Sampling rate (ℓ/min)	Total sample vol. (ℓ)	Sampler height (ft)
North transect, 1 mile	1	Highland and Ash	17.9	1.23	1,320	5.0
North transect, 1/2 mile	2	Central and Ash	17.7	1.26	1,342	5.0
North transect, 1/4 mile	3	Ponca and Ash	17.7	1.26	1,335	5.0
North transect, 1/8 mile	4	Otoe and Ash	17.6	1.34	1,418	5.0
North transect, 0 mile	5	South and Ash	17.5	1.34	1,412	5.0
South transect, 1/2 mile	6	See map	17.0	1.28	1,309	5.0
South transect, 1/4 mile	7	See map	17.2	1.41	1,458	5.0
South transect, 1/8 mile	8	See map	17.2	1.42	1,457	5.0
South transect, 0 mile	9	See map	17.6	1.44	1,516	5.0
East transect, 1 mile	10	Highway 60 at Arkansas River	17.9	1.37	1,462	5.0
East transect, 1/2 mile	11	Highway 60 and 77	17.7	1.23	1,307	5.0
East transect, 1/4 mile	12	1/4 mile } West of Highway 77 on	17.5	1.20	1,253	5.0
East transect, 1/8 mile	13	3/8 mile } Highway 60	17.2	1.49	1,542	5.0
East transect, 0 mile	14	1/2 mile }	16.8	0.81	819	5.0
West transect, 1/2 mile	15	1/2 mile west of Waverly on Highway 60	18.1	1.34	1,456	5.0
West transect, 1/4 mile	16	1/4 mile west of Waverly on Highway 60	18.2	0.97	1,057	5.0
West transect, 1/8 mile	17	1/8 mile west of Waverly on Highway 60	18.2	0.98	1,076	5.0
West transect, 0 mile	18	Highway 60 and Waverly	18.2	1.23	1,344	5.0
Pipeline pumping station	19	Cherokee Pipe Line Company, Highway 60	18.9	0.89	1,005	5.0
Bulk loading rack	20	Highway 60	18.7	1.36	1,528	5.0

Dustfall Sampling

Dustfall samples were collected at the following air sampling stations for the same time period in which air samples were collected.

D-1, Station 5
D-2, Station 9
D-3, Station 14
D-4, Station 18
D-5, Station 19
D-6, Station 20

Water Sampling

Water effluent samples, W-1 and W-2, were collected at the biodegradation pond discharge point at 8:00 a.m. and 8:00 p.m.

Meteorological Conditions

The weather conditions during the sampling period are presented in Table A-2.

Table A-2. WEATHER CONDITIONS DURING SAMPLING AT CONOCO OIL COMPANY, PONCA CITY, OKLAHOMA

Time	Temp. (°C)	Wind Speed (mph)	Wind Direction	Precipitation
0056	-1.1	4.6	N	None
0158	-1.1	4.6	N	None
0256	-1.1	5.7	N	None
0356	0	4.6	N	None
0456	1.1	4.6	W	None
0558	2.2	4.6	NNW	None
0656	2.2	6.9	WSW	None
0758	7.2	5.7	E	None
0857	7.8	5.7	SW	None
0959	8.9	9.2	NNW	None
1057	11.1	5.7	NNW	None
1158	11.1	5.7	NW	None
1257	11.1	4.6	W	None
1358	11.1	11.5	NW	None
1459	12.2	4.6	W	None
1555	12.8	4.6	WSW	None
1659	13.3	4.6	NE	None
1758	12.2	8.0	NW	None
1859	10.0	4.6	WSW	None
1958	7.2	5.7	SW	None
2059	6.1	5.7	S	None
2158	3.9	5.7	S	None
2257	3.9	5.7	SSW	None
2358	4.4	4.6	W	None

MOBIL OIL COMPANY, PAULSBORO, NEW JERSEY

PRESAMPLING SITE VISIT

The presampling site visit was conducted on April 7, 1976, at the Mobil Oil refinery facility at Paulsboro, New Jersey. Mr. Harvey Stocker of Mobil Oil assisted in the visit.

The Mobil Oil Refinery is located approximately 20 miles southwest of Camden, New Jersey, in the township of Greenwich. The residential sections of Paulsboro border the plant grounds on the east and south. The Delaware River is on the northern boundary, and inaccessible marshland is on the western boundary. The nearest major roadway, Interstate 295, is over 1 mile to the south of the refinery. At least five other major oil refineries, however, are located within 15 miles of each other in the area south and west of Philadelphia-Camden. Figure A-4 shows the general locations of the Mobil, Texaco, Arco, BP, Gulf, and Sunoco refineries. According to statistics as of January 1, 1975,[1] these six refineries account for 5.6% of the crude capacity of the United States.

The location of the EDB-related operations is shown in Figure A-5. All of the operations involving EDB are in the northeast section of the refinery. The exact locations of the lead mix storage and mixing facilities, the leaded gasoline storage area, the pipeline pumping station and the bulk truck loading rack are designated in Figure A-5. No details of the mode of operations were obtainable although they are assumed to be similar to those at Conoco. In the process of conducting the survey, three additional bulk loading stations, not belonging to Mobil Oil, were observed in the immediate vicinity. They were operated by the Sun Oil Company, Exxon, and BP Oil Company. Their locations are also indicated in Figure A-5. As their existence was unsuspected, no information of their operation was obtained.

The personnel at Mobil Oil could not provide any information concerning the quantity of leaded gasoline dispensed at the bulk loading station. Trucks were reported to be loaded through the top using a nozzle extending to the bottom of the receiving tank to avoid an open stream of gasoline. The refinery aqueous effluents are discharged into the Delaware River directly from plant property and could not be obtained.

FIELD SAMPLING

Field sampling was conducted on April 13, 1976. Air, soil, and dustfall samples were collected. The complete description of the sampling sites, the sampling, and the meteorological conditions follows.

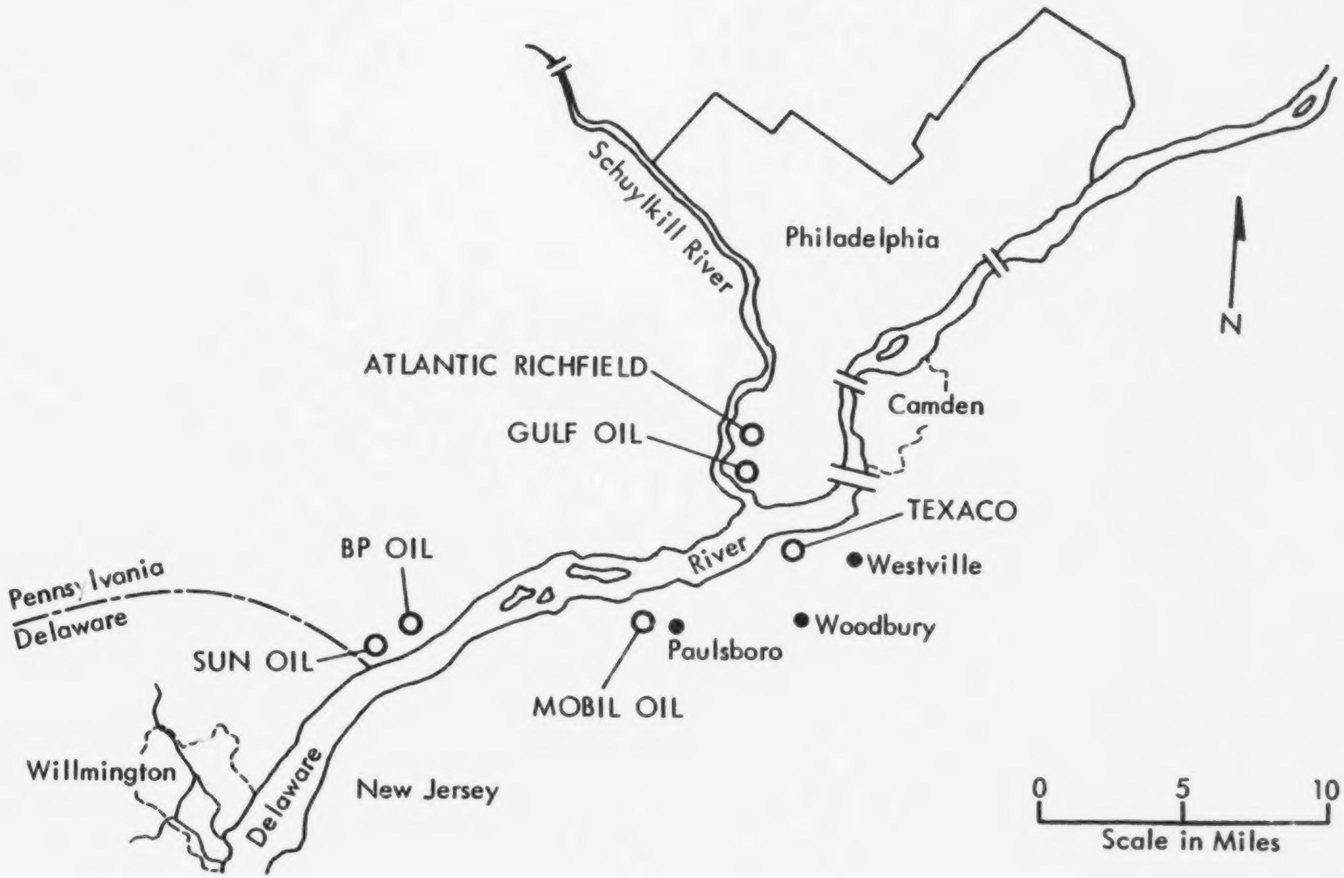
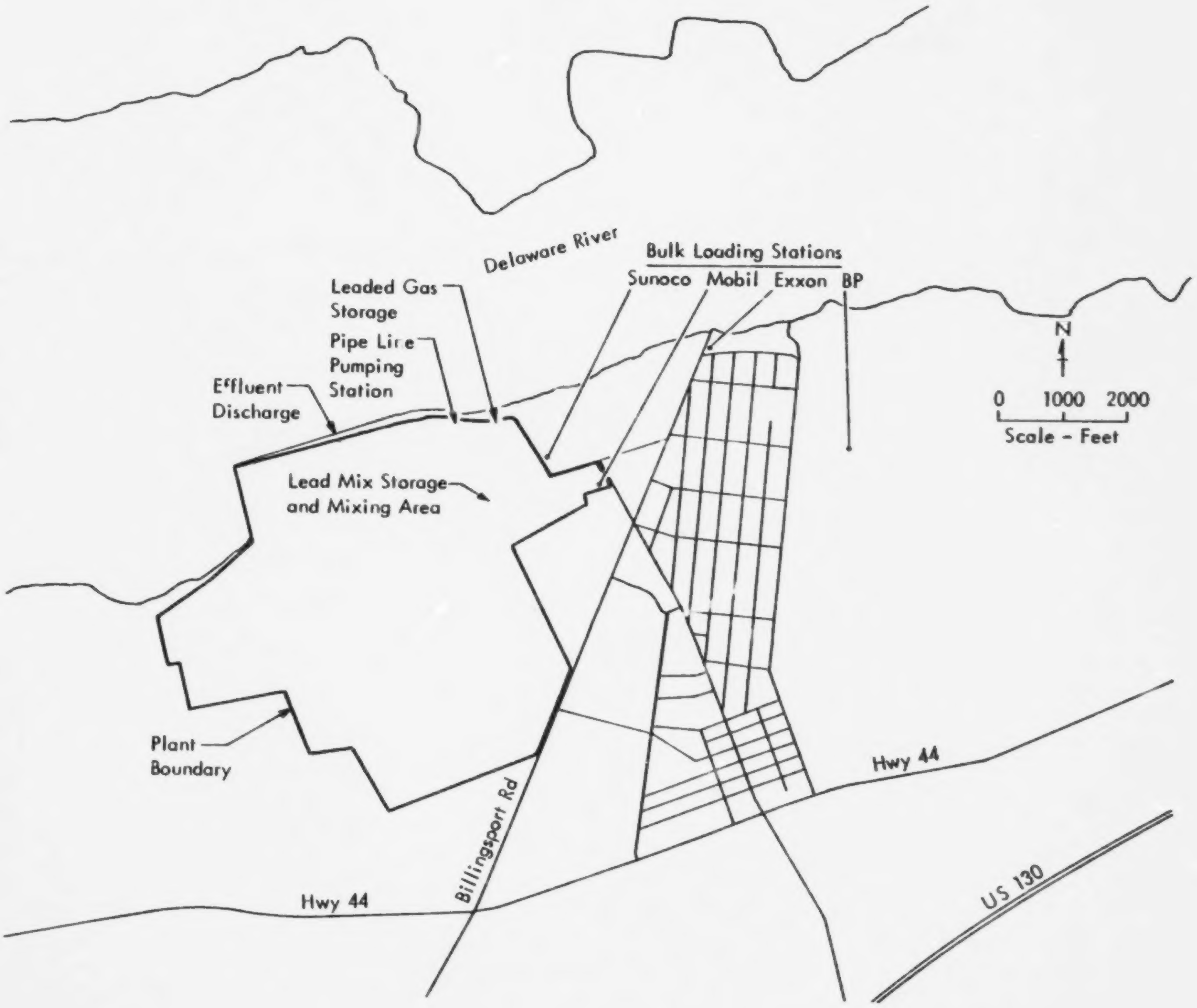

Philadelphia
Schuylkill River
N
ATLANTIC RICHFIELD
GULF OIL
Camden
TEXACO
Westville
Woodbury
River
Paulsboro
BP OIL
Pennsylvania
Delaware
SUN OIL
MOBIL OIL
Willmington
Delaware
New Jersey
0
5
10
Scale in Miles

Figure A-4. Location of oil refineries in the Philadelphia area.



Delaware River
Bulk Loading Stations
Sunoco
Mobil
Exxon
BP
Leaded Gas Storage
Pipe Line Pumping Station
Effluent Discharge
Lead Mix Storage and Mixing Area
Plant Boundary
N
0
1000
2000
Scale - Feet
Billingsport Rd
Hwy 44
Hwy 44
US 130

Figure A-5. Mobil Oil Refinery, Paulsboro, New Jersey.

Air Sampling

Nine air sampling stations were located along south, southeast, and east transects starting at the plant boundary. Four additional sites were to the northeast of the refinery. The stations along the east transects were at 0, 1/4, 1/2, and 1 mile, starting at the Mobil Oil Refinery bulk loading racks. Stations were set at 0, 0.2, 0.4, 0.6, and 1.0 to the south of the bulk loading rack. One station was positioned 1/4 mile to the southeast of the loading rack. One site to the north of the bulk loading station was set immediately to the east of the Sun Oil Company bulk loading rack. A second station 1/4 mile further north was approximately 1/4 mile east of the Mobil Oil Company pipeline pumping station. A station 1/2 mile northeast of the Mobil Oil Refinery was placed directly east of the Exxon bulk loading rack. The final station was placed 1/2 mile to the east of the Exxon bulk loading rack. The locations of all the stations are indicated in Figure A-6. Exact descriptions of the locations plus the air sampling data are listed in Table A-3.

Soil Sampling

Soil samples were collected at the following air sampling stations.

S-1, Station 1
S-2, Station 2
S-3, Station 3
S-4, Station 4
S-5, Station 5
S-6, Station 6
S-7, Station 7
S-8, Station 8
S-9, Station 9
S-10, Station 10
S-11, Station 11
S-12, Station 12
S-13, Station 13

Dustfall Sampling

Dustfall samples were collected at the following air sampling stations over the same period that air samples were being collected.

D-1, Station 1
D-2, Station 2
D-3, Station 3
D-4, Station 6
D-5, Station 8
D-6, Station 9
D-7, Station 10
D-8, Station 13

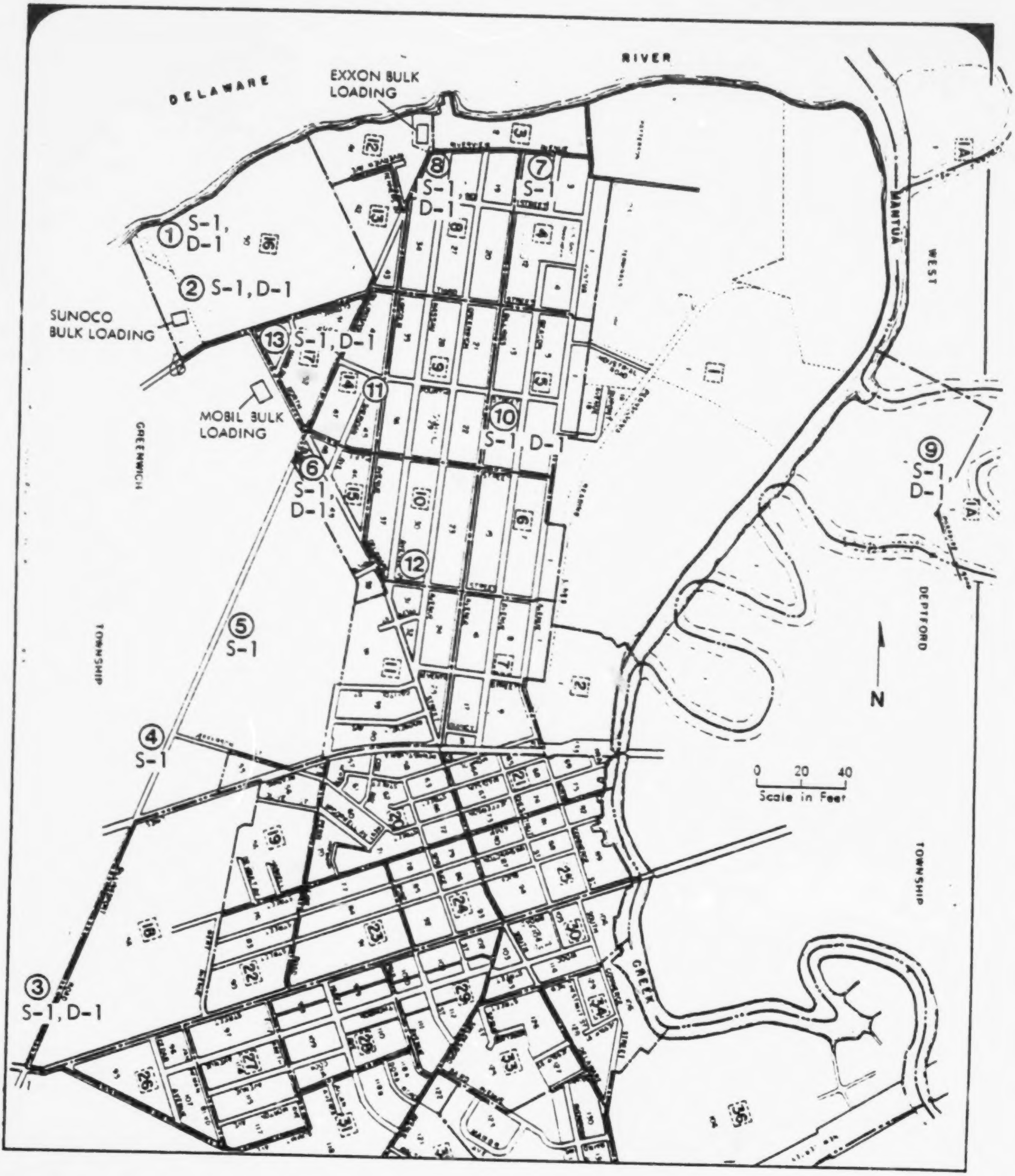

DELAWARE
RIVER
EXXON BULK LOADING
SUNOCO BULK LOADING
MOBIL BULK LOADING
① S-1, D-1
② S-1, D-1
③ S-1, D-1
④ S-1
⑤ S-1
⑥ S-1, D-1
⑦ S-1
⑧ S-1, D-1
⑨ S-1 D-1
⑩ S-1, D-1
⑪
⑫
⑬ S-1, D-1
GREENWICH
TOWNSHIP
MANTUA
CREEK
WEST
DEPTFORD
TOWNSHIP
N
0 20 40
Scale in Feet

Figure A-6. Sampling locations at the Mobil Oil Refinery.

Table A-3. AIR SAMPLING DATA FROM MOBIL OIL COMPANY REFINERY, PAULSBORO, NEW JERSEY

Area	Sample No.	Exact location	Total sampling time (hr)	Sampling rate (ℓ/min)	Total sample vol. (ℓ)	Sampler height (ft)
North transect, pipeline	1	See map	17.1	1.21	1,242	5.0
North transect, Sunoco	2	See map	17.0	1.18	1,205	5.0
South trasect, 1 mile	3	Billingsport Road and Broad Street	17.8	1.26	1,348	5.0
South transect, 1/2 mile	4	Billingsport Road and Jefferson Street	17.6	1.28	1,345	5.0
South transect, 1/4 mile	5	Billingsport Road at Parking Lot	17.4	1.30	1,353	5.0
South transect, 0 mile	6	Delaware Street and Billingsport Road	17.1	1.02	1,051	5.0
Northeast transect, 1/2 mile	7	Riverview and Beacon	17.8	1.26	1,346	5.0
Northeast transect, Exxon	8	West Riverview	17.8	1.29	1,377	5.0
East transect, 1 mile	9	Paradise Road	18.2	1.02	1,120	5.0
East transect, 1/2 mile	10	Billings and 4th	17.8	1.41	1,505	5.0
East transect, 1/4 mile	11	Sheridan and 4th	16.6	1.05	1,045	5.0
Southeast transect, 1/4 mile	12	Nassau and 6th	16.7	1.32	1,325	5.0
Bulk loading	13	Delaware Street and Hoffman Avenue	17.7	1.31	1,385	5.0

Meteorological Conditions

The weather conditions existing during the sampling period are summarized in Table A-4.

Table A-4. WEATHER CONDITIONS DURING SAMPLING AT MOBIL OIL COMPANY, PAULSBORO, NEW JERSEY

Time	Temp. (°C)	Wind Speed (mph)	Wind Direction	Precipitation
0600	0.6	8.1	W	None
0700	4.4	8.1	W	None
0800	7.2	12.7	WNW	None
0900	9.4	13.8	NW	None
1000	11.7	11.5	W	None
1100	12.2	16.1	W	None
1200	13.9	11.5	WNW	None
1300	15.6	20.7	W	None
1400	16.7	16.1	W	None
1500	17.2	18.4	WNW	None
1600	17.2	16.1	WNW	None
1700	16.7	15.0	W	None
1800	15.6	13.8	W	None
1900	13.3	6.9	WSW	None
2000	12.2	8.1	WSW	None
2100	11.7	10.4	WSW	None
2200	10.6	8.1	WSW	None
2300	9.4	6.9	SW	None
2400	8.3	6.9	SW	None

RETAIL GASOLINE AND HIGHLY TRAFFICKED URBAN, PHOENIX, ARIZONA

PRESAMPLING SITE VISIT

A presampling site visit was conducted at Phoenix, Arizona, on February 9 and 10, 1976. The purpose of the visit was to locate sites fitting the categories of retail gasoline and highly trafficked urban. Assistance in locating sites was obtained from the following:

Mr. Robert Taylor	Director, Bureau of Air Sanitation Maricopa County Health Department Phoenix, Arizona
Mr. Robert Evans	Bureau of Air Sanitation Maricopa County Health Department Phoenix, Arizona

The site chosen for retail gasoline was the intersection of 32nd Street and Shea Avenue located in the northeast section of Phoenix. As indicated in Figure A-7, four retail gasoline stations were located at this intersection, and a fifth station was located approximately 1/3 mile east on Shea Avenue. The approximate quantity of gasoline sold by each station is shown below:

Arco	35,000 gal/month
Giant	95,000 gal/month
Standard	45,000 gal/month
Shell	40,000 gal/month
Union	20,000 gal/month

Air sampling sites were established out 1 mile from the intersection in a western, southern, and eastern direction and out 3/4 mile in the northern direction. No site was set at 1 mile north due to the presence of two retail gasoline stations at that intersection. The total automobile traffic through the intersection was 38,000 vehicles per day. A small shopping center was located on the northwest corner of the intersection. Several small businesses were present within 1/4 mile of the intersection in all directions. The area became residential in all directions beyond approximately 1/4 mile.

The roadway chosen for highly trafficked urban sampling was a north-south running section of Interstate 17. This section was chosen to allow the air sampling stations to be placed east and west of the highway as

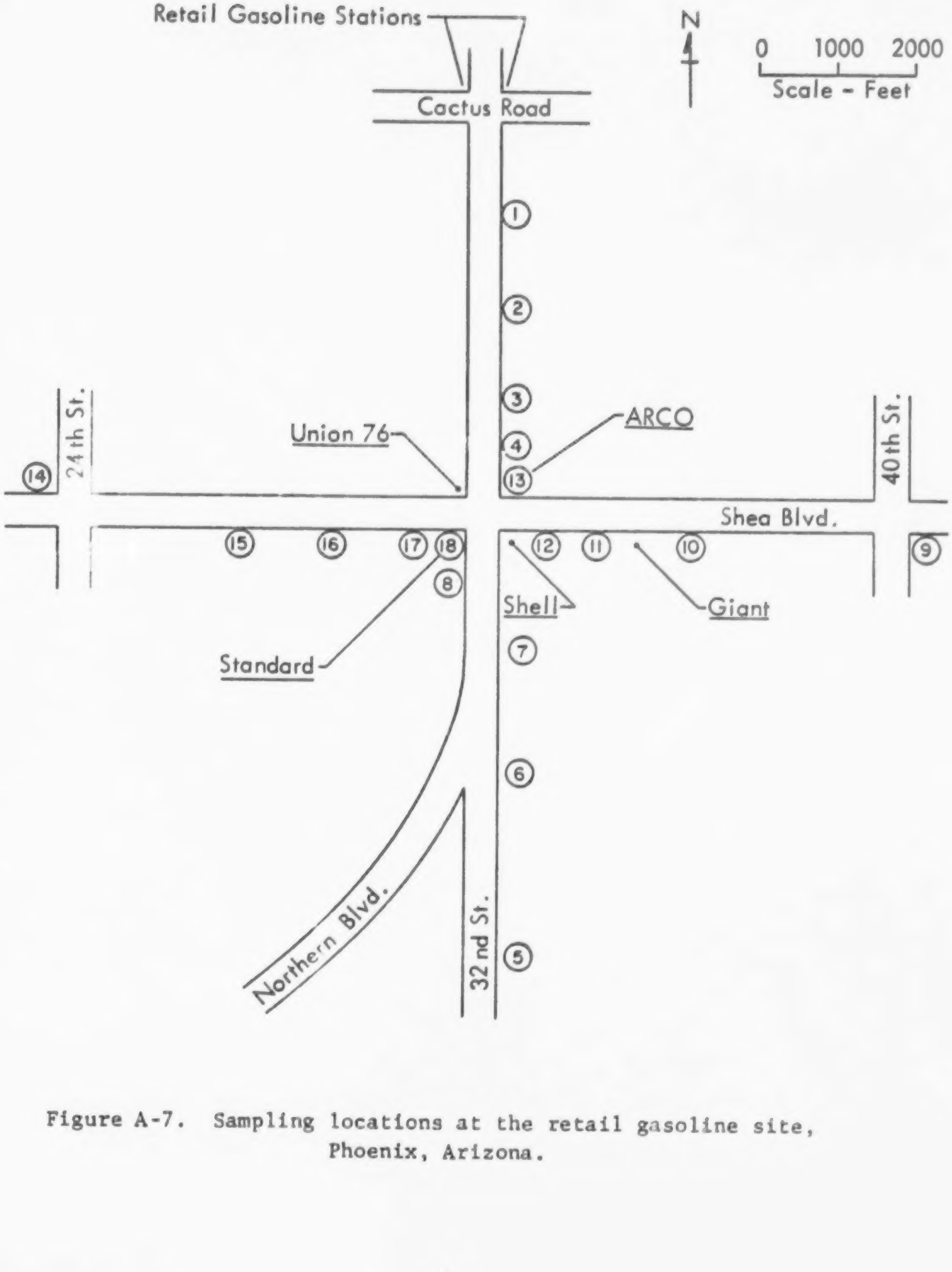

Retail Gasoline Stations
N
0 1000 2000
Scale - Feet
Cactus Road
1
2
3
4
13
ARCO
Union 76
24th St.
14
40th St.
Shea Blvd.
15
16
17
18
12
11
10
9
8
Shell
Giant
Standard
7
6
5
Northern Blvd.
32 nd St.

Figure A-7. Sampling locations at the retail gasoline site, Phoenix, Arizona.

the wind patterns are predictably in these directions. Thus, the wind could be expected to be blowing across the road more than with the road. Approximately one block west of I-27 was 27th Avenue. For the purpose of setting the exact sampling locations, I-27 and 27th Avenue were considered as the line source. The average daily traffic loads were 80,000 and 16,000 vehicles per day, respectively. The air sampling stations were positioned on Montebello, a lightly travelled residential road. The nearest major east-west streets were Bethany Home, 1/4 mile north, and Camelback, 3/4 mile south. No retail gasoline stations were within 1/4 mile of Montebello.

FIELD SAMPLING

Field sampling was conducted on February 26, 1976, at the retail gasoline site, and on February 24, 1976, at the highly trafficked urban site. A full description of the sampling and the meteorological conditions follows.

Retail Gasoline/Air Sampling

Eighteen air sampling stations were positioned to the north, south, east, and west of the intersection of 32nd Avenue and Shea. Four were located both south at 1/8, 1/4, 1/2, and 1 mile, four were east at 1/8, 1/4, 1/2, and 1 mile, four were north at 1/8, 1/4, 1/2, and 1 mile, and four were west at 1/8, 1/4, 1/2, and 1 mile. Two were set at the southwest and northeast corners of the intersections. The general locations are indicated in Figure A-8 with the exact locations listed in Table A-5. Pertinent air sampling data are also listed in Table A-5. The air samplers were all operated from 6:00 a.m. to 12:00 p.m. for a total of 18 hr.

Retail Gasoline/Meteorological Conditions

Weather conditions prevailing throughout the sampling period are summarized in Table A-6.

Highly Trafficked Urban/Air Sampling

Ten air sampling stations were located on east and west transects starting at 27th Avenue on the west and Black Canyon Highway on the east. Stations were placed at 0, 1/8, 1/4, 1/2, and 1 mile west of 27th Avenue and at 0, 1/8, 1/4, 1/2, and 3/4 mile east of Black Canyon Highway. The general locations are shown in Figure A-8 while the specific locations are given in Table A-7 along with sampling data. All stations were operated from 6:00 a.m. to 12:00 p.m. for a total of 18 hr.

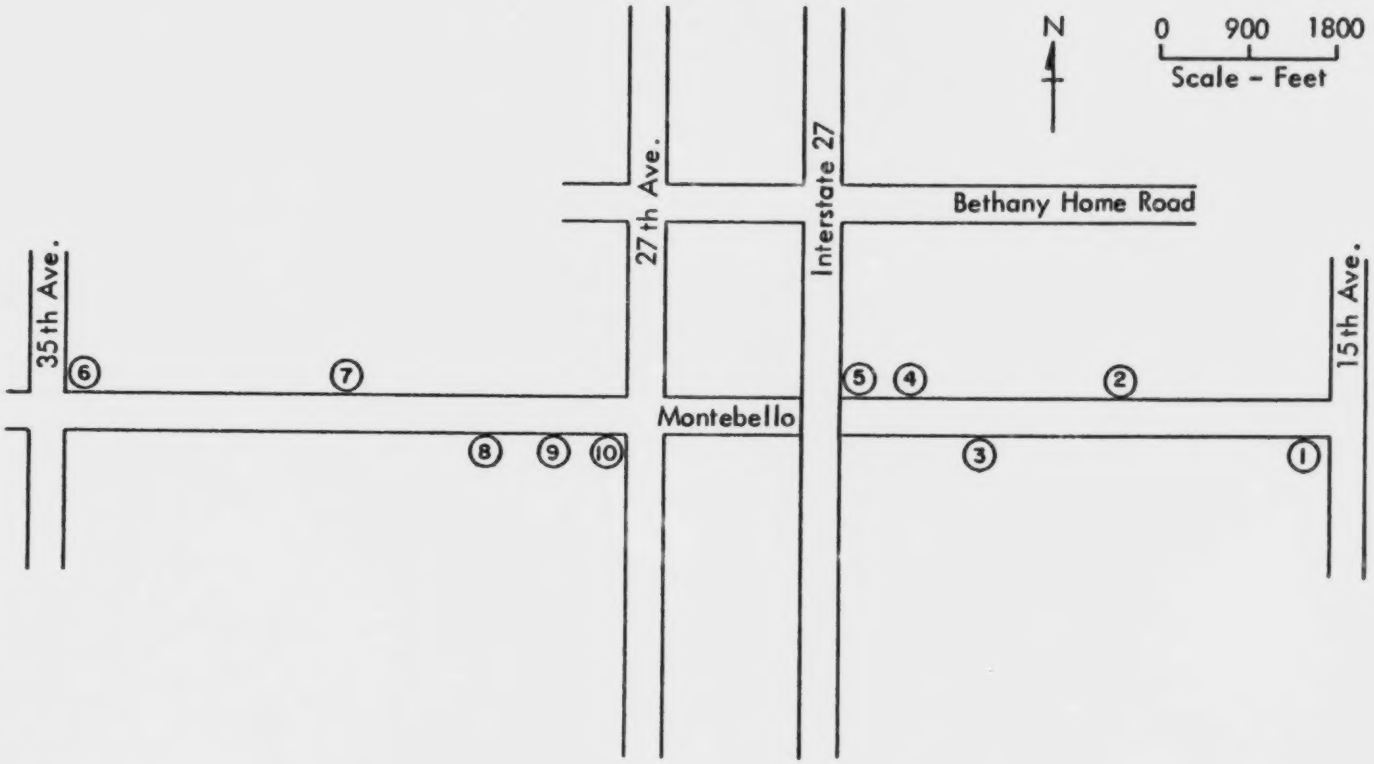

N
0
900
1800
Scale - Feet
Bethany Home Road
Interstate 27
27th Ave.
35th Ave.
15th Ave.
Montebello
①
②
③
④
⑤
⑥
⑦
⑧
⑨
⑩

Figure A-8. Sampling locations at the highly trafficked urban site, Phoenix, Arizona.

Table A-5. AIR SAMPLING DATA FOR THE RETAIL GASOLINE SITE, PHOENIX, ARIZONA

Area	Sample No.	Exact location	Total sampling (hr)	Sampling rate (ℓ/min)	Total sample vol. (ℓ)	Sampler height (ft)
North transect, 3/4 mile	1	3142 East Altadena	18.0	0.75	822	5.0
North transect, 1/2 mile	2	3146 East Cholla	18.3	1.00	1,092	5.0
North transect, 1/4 mile	3	3134 East Desert Cove	18.4	0.61	673	5.0
North transect, 1/8 mile	4	1st National Bank of Arizona	18.5	0.69	766	5.0
South transect, 1 mile	5		a/	-	-	-
South transect, 1/2 mile	6	9621 North 32nd Street	18.2	0.97	1,061	5.0
South transect, 1/4 mile	7	3202 East Gold Dust	18.2	0.85	934	5.0
South transect, 1/8 mile	8	10240 North 32nd Street	18.6	0.72	849	5.0
East transect, 1 mile	9	10435 North 40th Street	18.5	0.95	1,055	5.0
East transect, 1/2 mile	10	10601 Becker	18.7	0.74	834	5.0
East transect, 1/4 mile	11	Guggy's Restaurant	18.6	1.00	1,068	5.0
East transect, 1/8 mile	12	See map	18.7	1.00	1,116	5.0
East transect, 0 mile	13	Arco Gasoline Station	18.8	0.88	987	5.0
West transect, 1 mile	14	10601 North 24th Place	18.1	1.05	1,136	5.0
West transect, 1/2 mile	15	2748 Cannon	18.3	0.80	885	5.0
West transect, 1/4 mile	16	2944 Cannon	18.6	0.86	964	5.0
West transect, 1/8 mile	17	Open Field on 32nd Street	18.8	1.03	1,164	5.0
West transect, 0 mile	18	Standard Gasoline Station	19.1	0.59	675	5.0

---

a/ Sampler vandalized.

Table A-6. WEATHER CONDITIONS DURING SAMPLING AT THE RETAIL GASOLINE SITE, PHOENIX, ARIZONA

Time	Temperature (°C)	Wind		Precipitation
		Speed (mph)	Direction	
0555	7.8	6.9	ENE	None
0655	8.3	8.1	E	None
0755	8.9	4.6	NE	None
0856	11.7	4.6	SE	None
0955	15.6	3.5	W	None
1055	18.3	4.6	WNW	None
1155	21.1	4.6	WNW	None
1255	23.3	3.5	WSW	None
1355	24.4	4.6	ESE	None
1455	26.7	5.8	WNW	None
1556	26.7	3.5	N	None
1655	26.7	5.8	W	None
1755	25.6	8.1	W	None
1855	22.8	6.9	W	None
1955	20.0	4.6	W	None
2055	20.0	5.8	W	None
2155	18.3	4.6	WNW	None
2255	16.11	0	N	None
2355	13.9	6.9	E	None

Table A-7. AIR SAMPLING DATA FOR THE HIGHLY TRAFFICKED URBAN SITE, PHOENIX, ARIZONA

Area	Sample No.	Exact location	Total sampling (hr)	Sampling rate (ℓ/min)	Total sample vol. (ℓ)	Sampler height (ft)
East transect, 7/8 mile	1	5658 North 19th Avenue	17.6	0.69	726	5.0
East transect, 1/2 mile	2	2044 West Montebello	17.7	0.86	915	5.0
East transect, 1/4 mile	3	2243 West Montebello	17.8	0.80	849	5.0
East transect, 1/8 mile	4	2344 West Montebello	17.9	0.81	873	5.0
East transect, 0 mile	5	5701 Black Canyon Highway	18.0	0.89	958	5.0
West transect, 1 mile	6	3443 West Montebello	17.5	0.82	860	5.0
West transect, 1/2 mile	7	3049 West Montebello	17.6	0.78	820	5.0
West transect, 1/4 mile	8	2904 West Montebello	17.6	0.34	359	5.0
West transect, 1/8 mile	9	2814 West Montebello	17.7	0.88	933	5.0
West transect, 0 mile	10	2526 West Montebello	17.9	0.59	631	5.0

Highly Trafficked Urban/Meteorological Conditions

The weather conditions existing during the sampling period are listed in Table A-8.

Table A-8. WEATHER CONDITIONS DURING SAMPLING AT THE HIGHLY TRAFFICKED URBAN SITE, PHOENIX, ARIZONA

Time	Temperature (°C)	Wind Speed (mph)	Wind Direction	Precipitation
0555	8.9	5.8	E	None
0655	8.3	6.9	NW	None
0755	8.9	5.8	WSW	None
0855	14.4	-	N	None
0955	16.7	5.8	WNW	None
1055	19.4	9.2	WNW	None
1155	19.4	8.1	NW	None
1255	20.6	6.9	SW	None
1355	20.6	8.1	WSW	None
1455	21.7	3.5	SE	None
1555	21.7	11.5	W	None
1655	21.1	8.1	WNW	None
1755	21.1	8.1	WNW	None
1855	19.4	5.8	NW	None
1956	18.3	3.5	WNW	None
2055	15.6	-	N	None
2155	13.9	3.5	E	None
2255	11.7	9.2	E	None
2355	11.1	3.5	SE	None

RETAIL GASOLINE AND HIGHLY TRAFFICKED URBAN, LOS ANGELES, CALIFORNIA

PRESAMPLING SITE VISIT

A presampling site visit was conducted at Los Angeles, California, on February 11 and 12, 1976. The purpose of the trip was to locate appropriate sites for sampling as retail gasoline and highly trafficked urban. The following provided assistance in the selection of potential areas for sampling.

Mr. Thomas Mullins	Southern California Air Pollution Control District, District Headquarters El Monte, California
Mr. Bill McBeth	Southern California Air Pollution Control District, District Headquarters El Monte, California

The retail gasoline site was located at the intersection of Bellflower Boulevard and Del Amo Boulevard. The north transect of Bellflower Boulevard and the east transect of Del Amo Boulevard were in Lakewood, California, while the south and west transects were the border between Lakewood and Long Beach, California. As shown in Figure A-9, three retail gasoline stations were located at this intersection. No information concerning the quantity of gasoline sold by these stations was available. Additional gasoline stations in the area which limited the boundaries of the sampling grid were at the following points: north, three stations at 1 mile; south, one station at 3/4 mile; east, two stations at 1/2 mile. Sampling stations were established out to 3/4 mile, 1/2 mile, 1/4 mile, and 1/2 mile to the north, south, east, and west, respectively. According to data provided by the State of California, Department of Transportation, 46,000 vehicles per day pass through the intersection of Bellflower Boulevard and Del Amo Boulevard. The area was predominately residential in all directions.

The roadway chosen to be sampled as highly trafficked urban was Interstate 405 also known as the San Diego Freeway. A section running west northwest-east southeast in Long Beach, California, was selected as the specific site. The freeway at this point runs parallel to the coast line and is approximately 3 miles inland. The wind direction is generally normal to the coast and thus blows across the interstate. The sampling stations were placed on Studebaker Road which runs north-south and is nearly perpendicular to the San Diego Freeway.

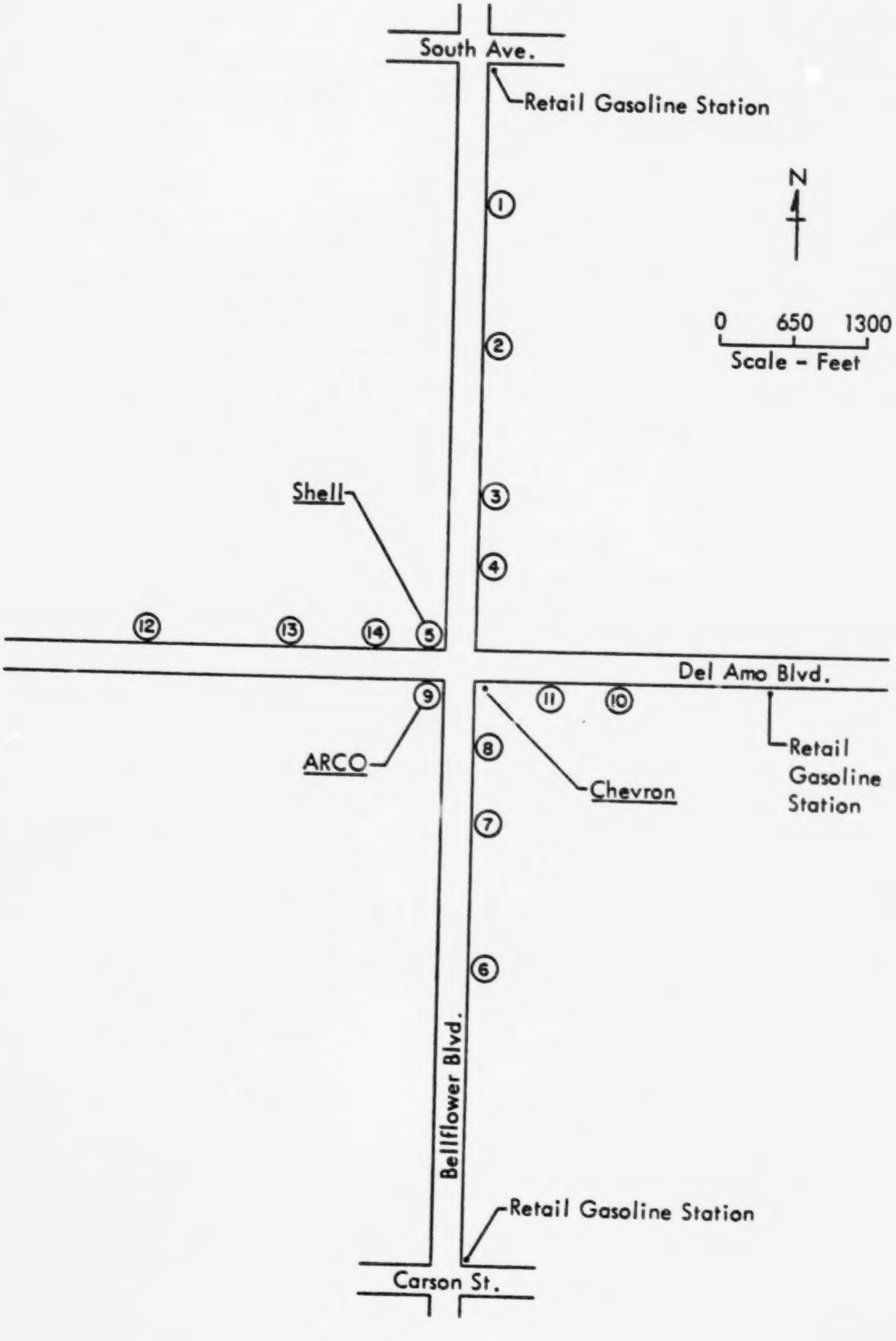

South Ave.
Retail Gasoline Station
N
0
650
1300
Scale - Feet
①
②
③
④
Shell
⑫
⑬
⑭
⑤
Del Amo Blvd.
⑨
ARCO
⑪
⑩
Retail Gasoline Station
⑧
Chevron
⑦
⑥
Bellflower Blvd.
Retail Gasoline Station
Carson St.

Figure A-9. Sampling locations at the retail gasoline site, Los Angeles, California.

The average daily traffic load for the San Diego Freeway at Studebaker Road was 144,000 vehicles per day. The average daily traffic load for Studebaker north and south of the freeway was 14,000 vehicles per day. The nearest retail gasoline stations were at least 1 mile away from the sampling station.

FIELD SAMPLING

Field sampling was conducted on March 2, 1976, at the retail gasoline site, and on March 4, 1976, at the trafficked urban site. A description of the sampling and the meteorological conditions follows.

Retail Gasoline/Air Sampling

Fourteen air sampling stations were set to the north, south, east, and west of the intersection of Bellflower Boulevard and Del Amo Boulevard at the following distances: north, 1/8, 1/4, 1/2, and 3/4 mile; south, 1/8, 1/4, and 1/2 mile; east, 1/8 and 1/4 mile; and west, 1/8, 1/4, and 1/2 mile. Two stations were installed on the northwest and southwest corners of the intersection and designated as 0 mile north and 0 mile south. A diagram of the intersection with locations at the air sampling stations and retail gasoline stations is shown as Figure A-9. Specific locations plus air sampling data are given in Table A-9. Samples were collected for 18 hr beginning at 6:00 a.m.

Retail Gasoline/Water Sampling

Rainfall occuring during the latter stages of the air sampling produced runoff water which was collected. A heavy shower was reported by the sampling personnel occuring at 1500 hour and lasting 15 min. Runoff water samples, W-1 and W-2, were collected at 1530 at the curb at the intersection of Bellflower and Del Amo and at 1/2 mile south of that intersection.

Retail Gasoline/Meteorological Conditions

The record of weather conditions existing during the sampling period is listed as Table A-10.

Highly Trafficked Urban/Air Sampling

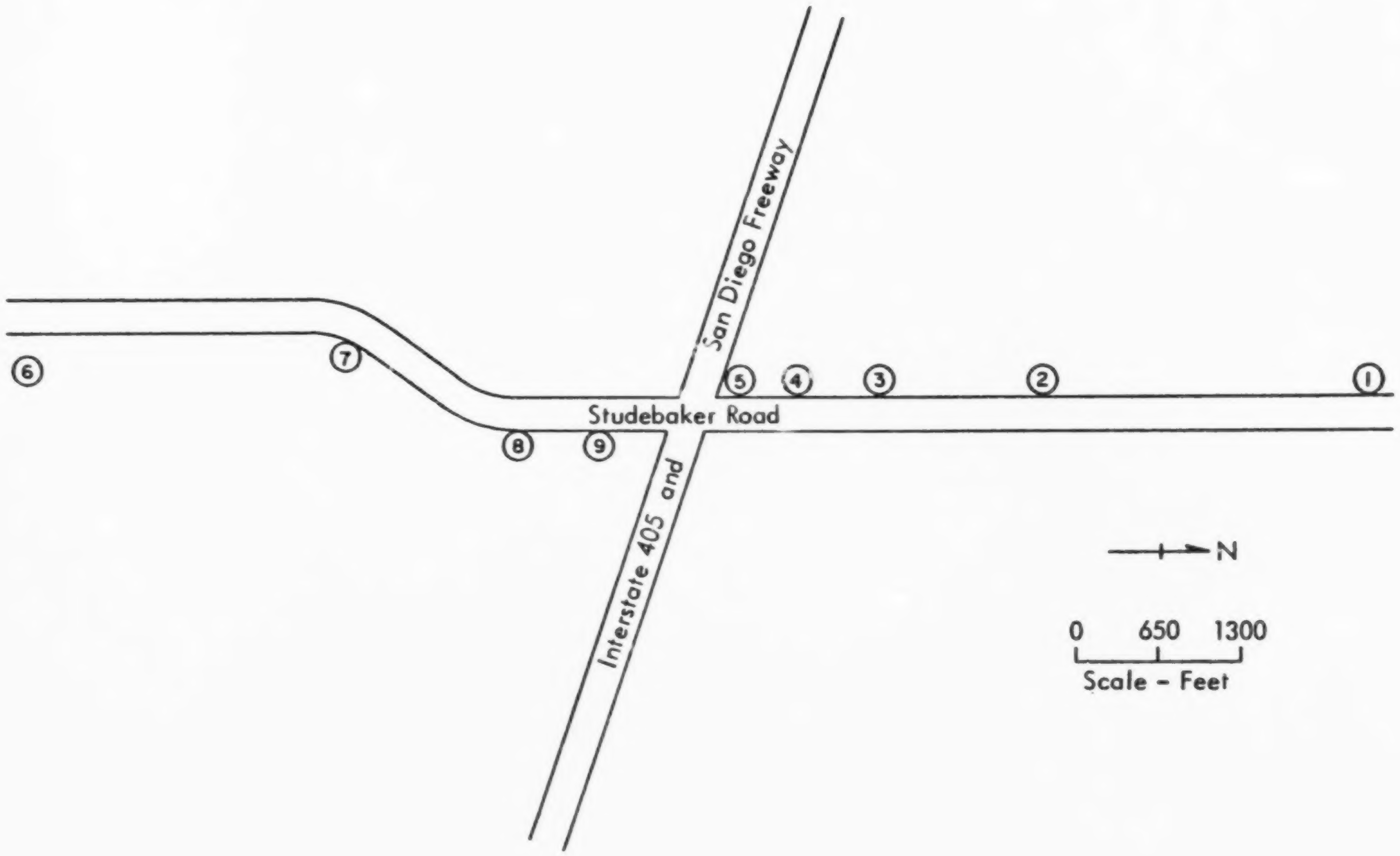
Nine air sampling stations were situated on the north and south transects of Studebaker Avenue starting at the San Diego Freeway. Stations were placed at 0, 1/8, 1/4, 1/2, and 1 mile to the north and at 1/8, 1/4, 1/2, and 3/4 mile to the south. These locations are indicated in Figure A-10 and are noted in detail in Table A-11 with the specific sampling data. The air samplers were run from 6:00 a.m. to 12:00 p.m. for a total of 18 hr.

Table A-9. AIR SAMPLING DATA FOR THE RETAIL GASOLINE SITE, LOS ANGELES, CALIFORNIA

Area	Sample No.	Exact location	Total sampling (hr)	Sampling rate (ℓ/min)	Total sample vol. (ℓ)	Sampler height (ft)
North transect, 3/4 mile	1	5626 Bellflower	13.0	1.47	1,147	5.0
North transect, 1/2 mile	2	5332 Bellflower	13.1	1.07	844	5.0
North transect, 1/4 mile	3	5114 Bellflower	13.2	1.12	889	5.0
North transect, 1/8 mile	4	4962 Bellflower	13.2	1.00	799	5.0
North transect, 0 mile	5	Shell Gasoline Station	13.7	0.90	736	5.0
South transect, 1/2 mile	6	4522 Bellflower	13.2	1.10	874	5.0
South transect, 1/4 mile	7	4712 Bellflower	13.4	1.15	923	5.0
South transect, 1/8 mile	8	4802 Bellflower	13.5	1.07	870	5.0
South transect, 0 mile	9	Arco Gasoline Station	13.4	1.07	866	5.0
East transect, 1/4 mile	10	4862 Ocana	13.1	1.17	916	5.0
East transect, 1/8 mile	11	4865 Coldbrook	13.1	1.18	924	5.0
West transect, 1/2 mile	12	4900 Clark	12.9	1.23	952	5.0
West transect, 1/4 mile	13	4902 Pearce	12.9	0.91	705	5.0
West transect, 1/8 mile	14	4903 Hersholt	13.0	0.85	658	5.0

Table A-10. WEATHER CONDITIONS DURING SAMPLING AT THE RETAIL GASOLINE SITE, LOS ANGELES, CALIFORNIA

Time	Temp. (°C)	Wind Speed (mph)	Wind Direction	Precipitation
0600	6.1	1	NE	None
0700	6.7	2	NE	None
0800		-	-	None
0900	12.2	8	N	None
1000	11.7	7	N	None
1100	13.3	7	E	None
1200	11.7	7	ESE	None
1300	13.3	16	E	None
1400	13.9	14	E	None
1500	11.1	8	E	Heavy shower
1600	12.2	10	E	Steady rain
1700	12.8	12	E	Steady rain
1800	12.8	17	E	Steady rain
1900	12.2	16	E	Steady rain



San Diego Freeway
Interstate 405 and
Studebaker Road
①
②
③
④
⑤
⑥
⑦
⑧
⑨
N
0
650
1300
Scale - Feet

Figure A-10. Sampling locations at the highly trafficked urban site, Los Angeles, California.

Table A-11. AIR SAMPLING DATA FOR THE TRAFFICKED URBAN SITE, LOS ANGELES, CALIFORNIA

Area	Sample No.	Exact location	Total sampling time (hr)	Sampling rate (ℓ/min)	Total sample vol. (ℓ)	Sampler height (ft)
North transect, 1 mile	1	2703 Studebaker	18.1	1.07	1,169	5.0
North transect, 1/2 mile	2	6846 La Marimba	18.1	1.05	1,140	5.0
North transect, 1/4 mile	3	2131 Studebaker	18.2	0.99	1,079	5.0
North transect, 1/8 mile	4	2009 Studebaker	18.2	1.10	1,204	5.0
North transect, 0 mile	5	1925 Studebaker	18.3	1.14	1,252	5.0
South transect, 1 mile	6	878 Lees Avenue	18.1	1.29	1,403	5.0
South transect, 1/2 mile	7	1283 Studebaker	18.1	1.08	1,176	5.0
South transect, 1/4 mile	8	1551 Studebaker	18.1	0.94	1,028	5.0
South transect, 1/8 mile	9	1725 Studebaker	18.2	1.26	1,371	5.0

Highly Trafficked Urban/Meteorological Conditions

The weather conditions prevailing during the sampling period are given in Table A-12.

Table A-12. WEATHER CONDITIONS DURING SAMPLING AT THE HIGHLY TRAFFICKED URBAN SITE, LOS ANGELES, CALIFORNIA

		Wind		
Time	Temp. (°C)	Speed (mph)	Direction	Precipitation
0600	5.0	3	N	None
0700	4.4	1	ENE	None
0800	7.2	9	ENE	None
0900	10.0	8	ENE	None
1000	12.2	3	ENE	None
1100	13.3	6	ESE	None
1200	13.9	15	E	None
1300	13.9	12	E	None
1400	14.4	9	E	None
1500	13.9	9	E	None
1600	13.3	7	E	None
1700	13.9	8	E	None
1800	12.8	8	E	None
1900	12.8	6	E	None
2000		3	E	None
2100		5	ENE	None
2200		7	ENE	None
2300		9	NE	None

RETAIL GASOLINE, CAMDEN, NEW JERSEY

PRESAMPLING SITE VISIT

A presampling site visit was conducted on April 8, 1976. The goal of the trip was to locate a site for limited sampling. Assistance was provided by Captain Peter Paull, City of Camden Police Department. The area chosen for sampling was a section of Haddon Avenue in the southeast part of the city. The first sampling station was placed at Euclid and Haddon, directly southwest of two retail gasoline stations. Two additional sites were located 0.2 and 0.6 miles to the southeast on Haddon Avenue.

The traffic level on Haddon Avenue was reported to be 13,000 vehicles per day. The area was generally residential with small businesses on Haddon Avenue.

Field Sampling

Field sampling was conducted on April 18, 1976. The locations of the air sampling stations are shown in Figure A-11. Exact locations plus sampling data are given in Table A-13. Air was collected from 0700 to 1900.

Meteorological Conditions

The weather conditions for the actual sampling period are given in Table A-14.

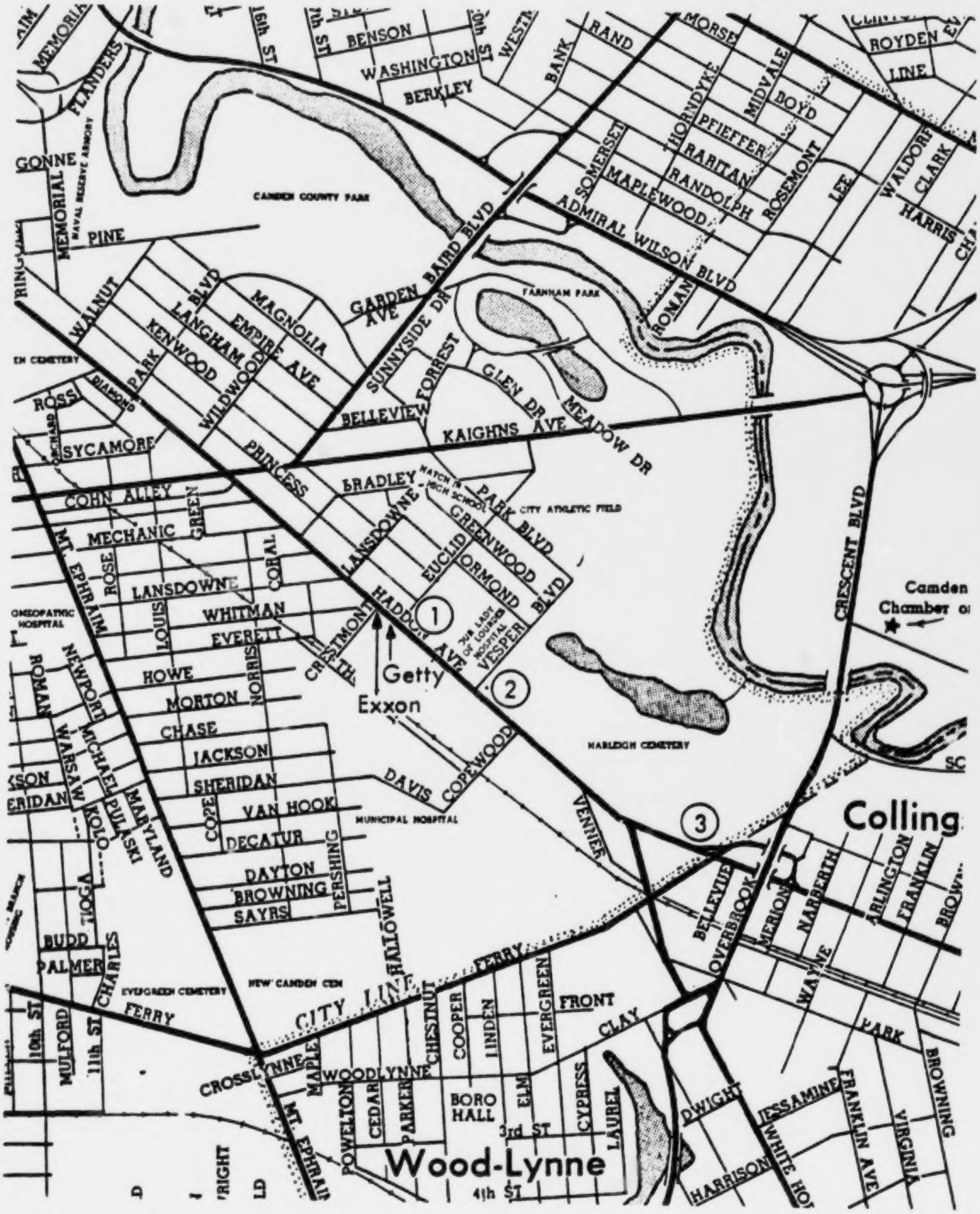

Camden Chamber of
Getty
Exxon
1
2
3
Colling
Wood-Lynne
CAMDEN COUNTY PARK
FARNHAM PARK
HARLEIGH CEMETERY
CITY ATHLETIC FIELD
MUNICIPAL HOSPITAL
ADMIRAL WILSON BLVD
BAIRD BLVD
CRESCENT BLVD
KAIGHNS AVE
HADDON AVE
PARK BLVD
MT. EPHRAIM
CITY LINE
FERRY
CROSSLYNNE
WOODLYNNE
BORO HALL

Figure A-11. Sampling locations at the retail gasoline site, Camden, New Jersey.

Table A-13. AIR SAMPLING DATA FOR THE RETAIL GASOLINE SITE, CAMDEN, NEW JERSEY

Area	Sample No.	Exact location	Total sampling time (hr)	Sampling rate (ℓ/min)	Total sample vol. (ℓ)	Sampler height (ft)
Southeast transect, 0 mile	1	1500 Haddon Avenue	11.7	0.99	693	5.0
Southeast transect, 0.2 mile	2	Harleigh Cemetery	12.2	0.68	503	5.0
Southeast transect, 0.6 mile	3	Harleigh Cemetery	12.0	1.10	796	5.0

Table A-14. WEATHER CONDITIONS DURING SAMPLING AT THE RETAIL GASOLINE SITE, CAMDEN, NEW JERSEY

		Wind		
Time	Temp. (°C)	Speed (mph)	Direction	Precipitation
0653	8.3	5.8	SW	None
0753	10.6	4.6	WSW	None
0853	16.7	8.1	WSW	None
0953	20.0	10.4	WSW	None
1053	21.7	15.0	SW	None
1153	22.8	15.0	SW	None
1255	22.8	11.5	SW	None
1353	23.9	12.7	SW	None
1454	23.9	12.7	SW	None
1553	23.9	10.4	SSW	None
1653	23.3	13.8	S	None
1753	21.1	11.5	S	None
1853	18.9	8.1	S	None
1953	17.2	8.1	S	None

SUBURBAN RESIDENTIAL, KANSAS CITY, MISSOURI

PRESAMPLING SITE VISIT

The site utilized for sampling was located at 12219 East 61st Street, Kansas City, Missouri. No actual presampling visit was required. The site is located in the northeast section of the city in a residential section. No heavily traveled roads were in the immediate vicinity. The nearest retail gasoline station was approximately 1 mile west of the site.

Field Sampling

Field sampling was conducted on March 18, 1976. One sampling station was deployed at the site. Figure A-12 indicates the location of the site, and Table A-15 provides the exact location and the air sampling data. The air sampler was in operation from 0600 to 2330. No specific weather data were recorded during the sampling period.

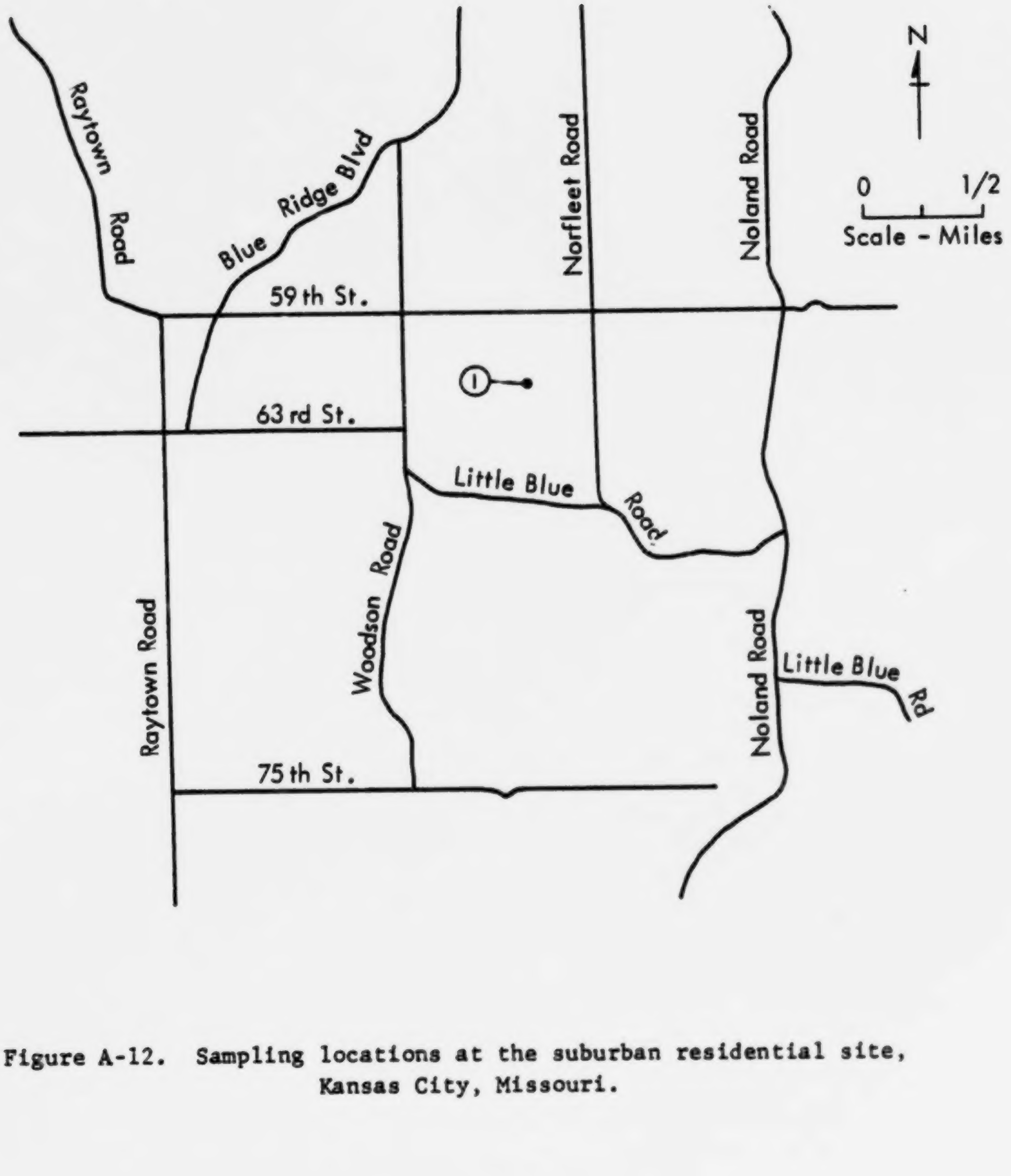

N
0
1/2
Scale - Miles
Raytown Road
Blue Ridge Blvd
Norfleet Road
Noland Road
59th St.
①
63rd St.
Little Blue Road
Woodson Road
Raytown Road
Noland Road
Little Blue Rd
75th St.

Figure A-12. Sampling locations at the suburban residential site, Kansas City, Missouri.

Table A-15. AIR SAMPLING DATA AT THE SUBURBAN RESIDENTIAL SITE, KANSAS CITY, MISSOURI

Area	Sample No.	Exact location	Total sampling time (hr)	Sampling rate (ℓ/min)	Total sample vol. (ℓ)	Sampler height (ft)
Suburban Kansas City	1	12219 East 61st Street	17.3	1.24	1,287	5.0

RURAL, NORTHWEST MISSOURI

PRESAMPLING SITE VISIT

The rural site was located in northwest Missouri, approximately 20 miles northeast of Maryville. The sampling station was placed on the farm of Mrs. M. Cobb. No highly trafficked road was in the vicinity. The nearest retail gasoline stations were 2 miles south of the site.

Field Sampling

Field sampling was conducted on March 13, 1976, using two adjacent sampling stations. Figure A-13 shows the general location of the site. The relevant sampling data are given in Table A-16. Air samples were collected from 0630 to 2400. The wind throughout the day was gusty from the south to southwest.

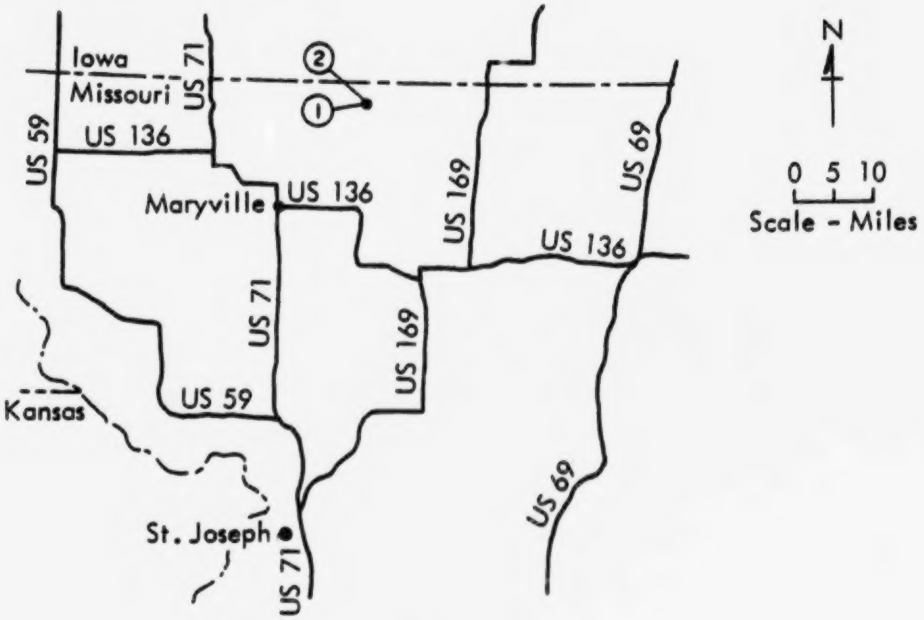

Iowa
Missouri
US 71
US 59
US 136
Maryville
US 136
US 169
US 69
US 136
US 71
US 169
US 59
Kansas
St. Joseph
US 71
US 69
②
①
N
0 5 10
Scale - Miles

Figure A-13. Sampling locations at the rural site, Maryville, Missouri.

Table A-16. AIR SAMPLING DATA FOR THE RURAL SITE, MARYVILLE, MISSOURI

Area	Sample No.	Exact location	Total sampling time (hr)	Sampling rate (ℓ/min)	Total sample vol. (ℓ)	Sampler height (ft)
Rural	1	20 Miles northeast of Maryville, Missouri	17.9	1.17	1,255	5.0
Rural	2	20 Miles northeast of Maryville, Missouri	17.7	1.33	1,405	5.0

STATE OF FLORIDA-USDA FUMIGATION CENTERS, WAHNETA AND FT. PIERCE, FLORIDA

PRESAMPLING SITE VISIT, WAHNETA, FLORIDA

A presampling site visit was conducted on May 3, 1976, at the State of Florida Fumigation Center. A preliminary general meeting was held with the following in attendance.

Mr. T. Harris	Officer-in-Charge, United States Department of Agriculture Animal and Plant Health Inspection Agency Winter Haven, Florida
Mr. J. Whitesides	Chief, Processing Plant Inspection and Fumigation Florida Department of Agriculture Winter Haven, Florida
Mr. W. Grierson	Professor of Horticulture Agriculture Research and Education Center Lake Alfred, Florida
Mr. M. Ismail	Plant Physiologist Department of Citrus University of Florida Lake Alfred, Florida
Mr. W. Miller	Agricultural Engineer University of Florida Lake Alfred, Florida
Dr. J. Going	MRI

The fumigation centers at both Wahneta, Florida, and Ft. Pierce, Florida, are used to fumigate grapefruit being exported to Japan. The purpose of the fumigation is to eradicate the Caribbean fruit fly, *Anastrepha suspensa*. Trucks containing about 1,000 boxes of grapefruit are driven into a fumigation chamber approximately 50 x 14 x 20 ft. The doors of the trailer are opened to expose the grapefruit, and the chamber is sealed. From 850 to 1,300 ml of EDB are poured into two electric fry pans prior to sealing the chamber. A circulating fan operating at 6,000 cfm is started, and the fry pans are heated to boil off the EDB.

After all the EDB has vaporized (15 min), the fumigation is continued for 2 hr. After 2 hr, an 18 x 18 in. port in the chamber door is opened while the circulation fan is vented to exhaust 40% of the air. After evacuating for 1 hr, the chamber is opened and the trailer doors are sealed by the fumigation officials. The trucks then proceed to a port to transfer their load to a ship.

EDB is obtained in 30-gal., 540-lb plastic or metal drums which are usually stored in one of the chambers until used. To obtain smaller quantities for transfer to the chambers, positive air pressure is used to force EDB as an open stream from the drums into plastic bottles. This is normally done at the end of the day by the last shift. To date, the two facilities had fumigated over 5,000 trucks or 5,000,000 boxes of grapefruit, mostly at the Ft. Pierce facility.

A third fumigation facility is maintained at Gainsville, Florida, and is used solely for fruit being transported to other citrus-growing regions in the United States. This facility was not sampled nor visited.

The first fumigation center is located approximately 2 miles south of Wahneta, Florida, and 16 miles south of Winter Haven, Florida, near the intersection of Highway 60 and State Road 655. The area is predominately rural, the closest residential area being Wahneta. Highway 60 runs east and west of the center and is 0.1 mile to the south. One small retail gasoline station is located on the northeast corner of the intersection of Highway 60 and State Road 655.

The facility has 12 chambers arranged with six on a side with a corridor down the middle. The ventilation fans and the frying pans are controlled from the corridor. Figure A-14 shows the physical arrangement of the facility plus locations of the open barrel of EDB and the exhaust fan. No aqueous effluents are produced by this facility.

Field Sampling

Field sampling was conducted on May 4, 1976, during which air, soil, and dustfall samples were collected. A complete description of the sampling sites, the sampling, and the meteorological conditions follows.

Air Sampling

Fifteen air sampling stations were located along the north, south, east, and west transects starting at the facility boundary. Additional stations were located in the corridor separating the chambers and in the office adjacent to the chambers. Locations of the 17 stations are shown in Figure A-15 and described more thoroughly in Table A-17. Six additional samplers were set at the north, south, east, and west 0-mile station and in the corridor and office.

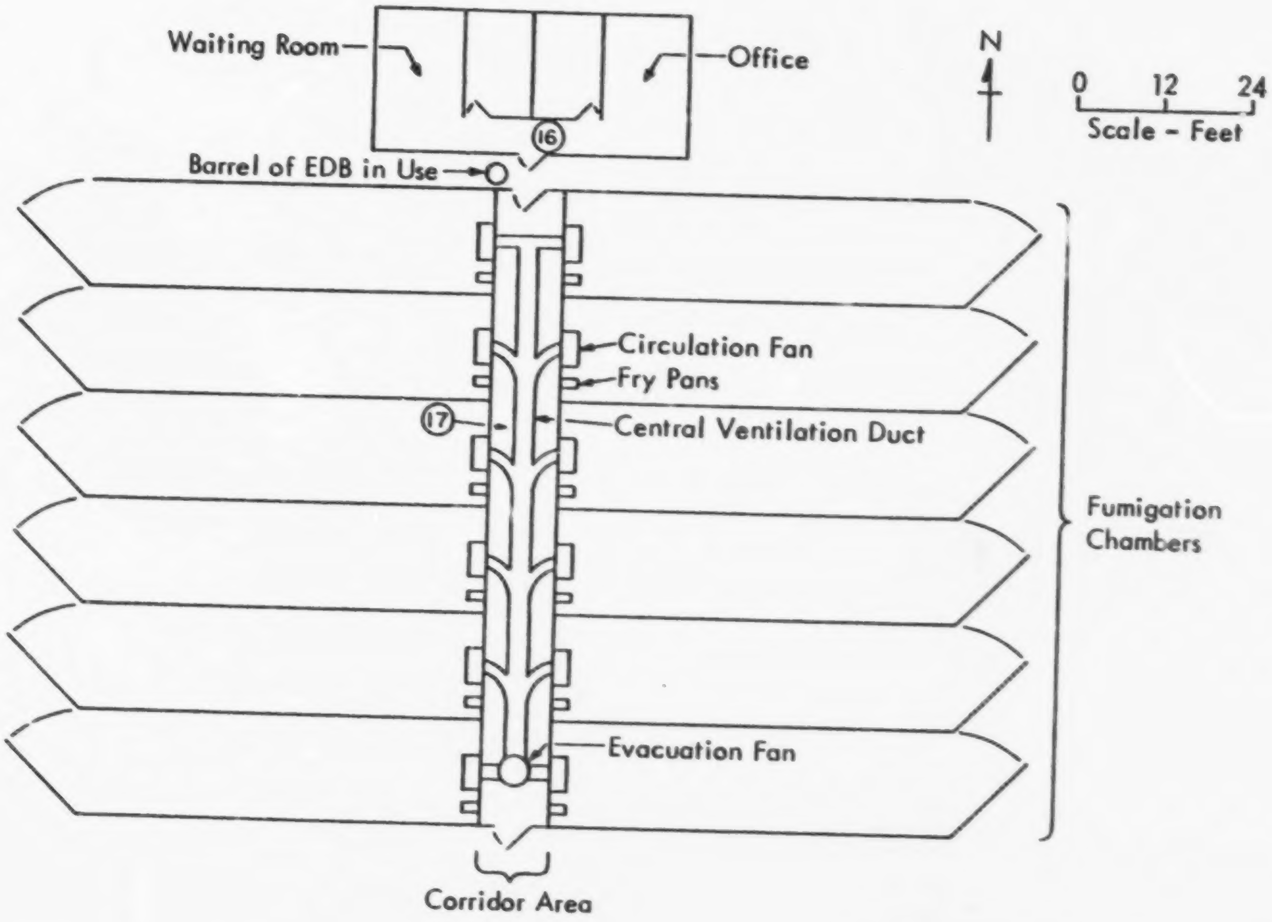
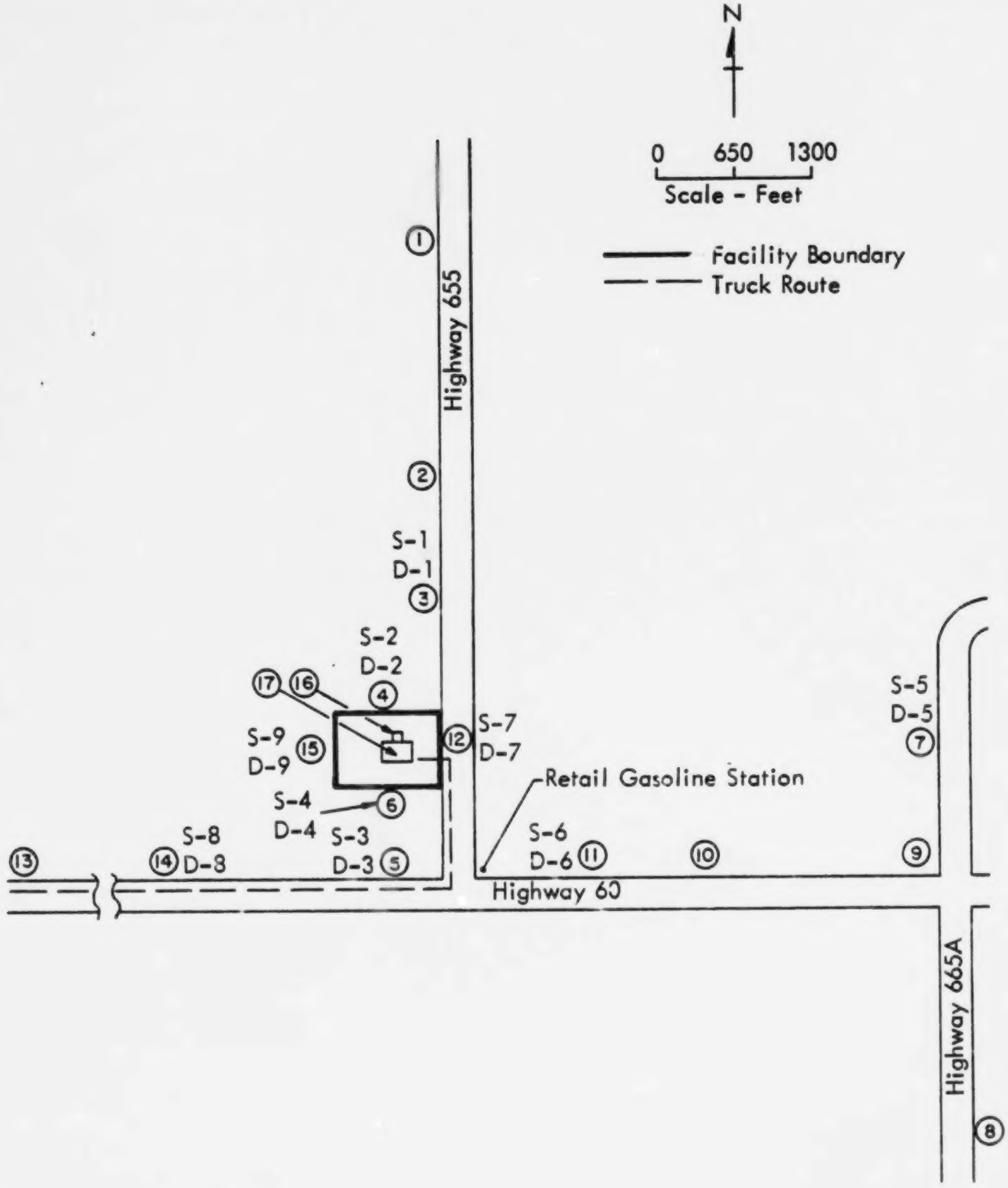

Waiting Room
Office
N
0
12
24
Scale - Feet
⑯
Barrel of EDB in Use
Circulation Fan
Fry Pans
⑰
Central Ventilation Duct
Fumigation Chambers
Evacuation Fan
Corridor Area

Figure A-14. State of Florida-USDA Fumigation Center, Wahneta, Florida.



N
0
650
1300
Scale - Feet
Facility Boundary
Truck Route
Highway 655
①
②
S-1
D-1
③
S-2
D-2
④
⑰
⑯
S-9
D-9
⑮
⑫
S-7
D-7
S-4
D-4
⑥
S-3
D-3
⑤
S-8
D-8
⑭
⑬
Retail Gasoline Station
S-6
D-6
⑪
⑩
⑨
S-5
D-5
⑦
Highway 60
Highway 665A
⑧

Figure A-15. Sampling locations at the Fumigation Center, Wahneta, Florida.

Table A-17. AIR SAMPLING DATA AT THE STATE OF FLORIDA-USDA FUMIGATION CENTER, WAHNETA, FLORIDA

Area	Sample No.	Exact location	Total sampling time (hr)	Sampling rate (*l*/min)	Total sample vol. (*l*)	Sampler height (ft)
North transect, 1/2 mile	1	1/2 Mile north on Highway 655	13.0	1.18	925	5.0
North transect, 1/4 mile	2	1/4 Mile north on Highway 655	13.4	1.19	952	5.0
North transect, 1/8 mile	3	1/8 Mile north on Highway 655	13.6	1.25	1,024	5.0
North transect, 0 mile	4	40 ft North of fumigation chambers	14.3	1.18	1,016	5.0
North transect, 0 mile	4a	40 ft North of fumigation chambers	2.3	1.15	156	5.0
North transect, 0 mile	4b	40 ft North of fumigation chambers	2.3	0.39	53	5.0
North transect, 0 mile	4c	40 ft North of fumigation chambers	2.9	0.39	67	5.0
South transect, 1/8 mile	5	1/8 Mile south on Highway 60	13.0	1.17	910	5.0
South transect, 0 mile	6	200 ft South of fumigation chambers	14.6	1.27	1,113	5.0
South transect, 0 mile	6a	200 ft South of fumigation chambers	2.4	0.38	55	5.0
South transect, 0 mile	6b	200 ft South of fumigation chambers	2.3	1.07	150	5.0
South transect, 0 mile	6c	200 ft South of fumigation chambers	2.8	1.07	179	5.0
East transect, 1/2 mile	7	1/2 Mile east on old Bartow Lake Wales Road	13.7	1.35	1,108	5.0
Southeast transect, 3/4 mile	8	1/4 Mile south of Highway 60 on Highway 655A	13.3	0.85	678	5.0
Southeast transect, 1/2 mile	9	1/2 Mile east on Highway 60	13.4	1.04	834	5.0
Southeast transect, 1/4 mile	10	1/4 Mile east on Highway 60	13.2	1.11	889	5.0
Southeast transect, 1/8 mile	11	1/8 Mile east on Highway 60	13.2	1.33	1,051	5.0
East transect, 0 mile	12	150 ft East of fumigation chambers	15.2	1.22	1,110	5.0
East transect, 0 mile	12a	150 ft East of fumigation chambers	2.5	0.78	117	5.0
East transect, 0 mile	12b	150 ft East of fumigation chambers	2.3	0.65	88	5.0
East transect, 0 mile	12c	150 ft East of fumigation chambers	2.8	0.66	111	5.0
Southwest transect, 1/2 mile	13	1/2 Mile west on Highway 60	13.6	0.92	750	5.0
Southwest transect, 1/4 mile	14	1/4 Mile west on Highway 60	13.2	0.74	581	5.0
West transect, 0 mile	15	300 ft West of fumigation chambers	14.6	1.03	895	5.0
West transect, 0 mile	15a	300 ft West of fumigation chambers	2.2	1.21	159	5.0
West transect, 0 mile	15b	300 ft West of fumigation chambers	2.6	1.21	184	5.0
West transect, 0 mile	15c	300 ft West of fumigation chambers	2.8	1.46	246	5.0
Office Building	16	Entrance hall of office building adjacent to fumigation chambers	14.0	1.32	1,105	5.0
Office Building	16a		2.1	1.52	192	5.0
Office Building	16b		2.6	1.50	232	5.0
Office Building	16c		2.8	1.04	176	5.0
Corridor	17	Midpoint of corridor between two banks of fumigation chambers	13.9	1.32	1,102	5.0
Corridor	17a		2.2	1.34	178	5.0
Corridor	17b		2.5	1.41	213	5.0
Corridor	17c		2.7	1.30	212	5.0

These were operated intermittently to collect short-term air samples for correlation of ambient air levels of EDB with facility operations. A summary of the fumigation operations occurring during the sampling period is given in Table A-18.

Soil Sampling

Soil samples were collected at the following air sampling stations.

S-1, Station 3
S-2, Station 4
S-3, Station 5
S-4, Station 6
S-5, Station 7
S-6, Station 11
S-7, Station 12
S-8, Station 14
S-9, Station 15

Dustfall Sampling

Dustfall samples were collected at the following air sampling stations over the same period that the air samples were collected.

D-1, Station 3
D-2, Station 4
D-3, Station 5
D-4, Station 6
D-5, Station 7
D-6, Station 11
D-7, Station 12
D-8, Station 14
D-9, Station 15

Meteorological Conditions

The weather conditions existing during the sampling period at the Orlando Airport are summarized in Table A-19.

Table A-18. FUMIGATION ACTIVITY AT THE WAHNETA FUMIGATION CENTER, MAY 4, 1976

Fumigation No.	Fumigation time	Evacuation time	EDB Used (g)
1	0945-1145	1145-1245	1,900
2	1055-1255	1255-1355	1,900
3	1430-1630	1630-1730	1,900
4	1535-1735	1735-1835	1,900
5	1615-1815	1815-1915	1,900
6	1645-1845	1845-1945	1,900
7	1745-1945	1945-2045	1,900
8	1830-2030	2030-2130	1,900
		Total grams used	15,200

Table A-19. WEATHER CONDITIONS DURING SAMPLING AT THE FUMIGATION CENTER, WAHNETA, FLORIDA, MAY 4, 1976

Time	Temp. (°C)	Wind Speed (mph)	Wind Direction	Precipitation
0800	23	11	N	None
0900	24	14	N	None
1000	26	14	NNE	None
1100	27	14	NNE	None
1200	29	11	NW	None
1300	28	15	NE	None
1400	29	17	N	None
1500	29	17	N	None
1600	28	15	NE	None
1700	27	17	NE	None
1800	25	15	ENE	None
1900	23	11	ENE	None
2000	21	10	ENE	None
2100	19	9	NNE	None
2200	18	9	NNE	None
2300	18	6	NNE	None
2400	16	7	NNE	None

PRESAMPLING SITE VISIT, FT. PIERCE, FLORIDA

A presampling site visit was conducted on May 5, 1976, at the State of Florida-USDA Fumigation Center, Ft. Pierce, Florida. Mr. J. Whitesides assisted in the survey. The facility is located just past the southern city limits of Ft. Pierce in the state-operated Farmers' Market. It is 1/8 mile west of U.S. 1 and 4 miles east of the Florida Turnpike. The surrounding areas are lightly populated residential. Highway 1 has numerous small commercial stores. Only one retail gasoline station, located 1/2 mile north of the facility on U.S. 1, was observed in the area. The fumigation facility is identical to the one near Wahneta except that it has 16 chambers rather than 12. A diagram showing the fumigation center, the barrel of EDB being used, and the position of the exhaust fan is shown in Figure A-16. No aqueous wastes are generated by the facility.

Field Sampling

Field sampling was carried out on May 6, 1976. Air, soil, dustfall, rainfall, and runoff water samples were collected. A complete description of the sampling sites, sampling activities, and meteorological conditions follows.

Air Sampling

Fifteen air sampling stations were positioned generally along north, south, east, and west transects starting near the facility boundary. Additional samplers were placed in the corridor separating the chambers and in the adjoining office building. Locations of the 17 stations can be seen in Figure A-17 and are described in Table A-20.

Five additional stations were set at the north, south, and west 0 mile sites and in the corridor and office. These were operated intermittently to collect short-term samples for correlation of ambient air concentrations with fumigation activities. A summary of the fumigation activities is given in Table A-21. In addition, two air samples were collected using a personnel sampler attached to two of the facility operators. The duty of those individuals was to enter the chamber, to pour the liquid EDB into the fry pan and to seal the truck after the fumigation was completed.

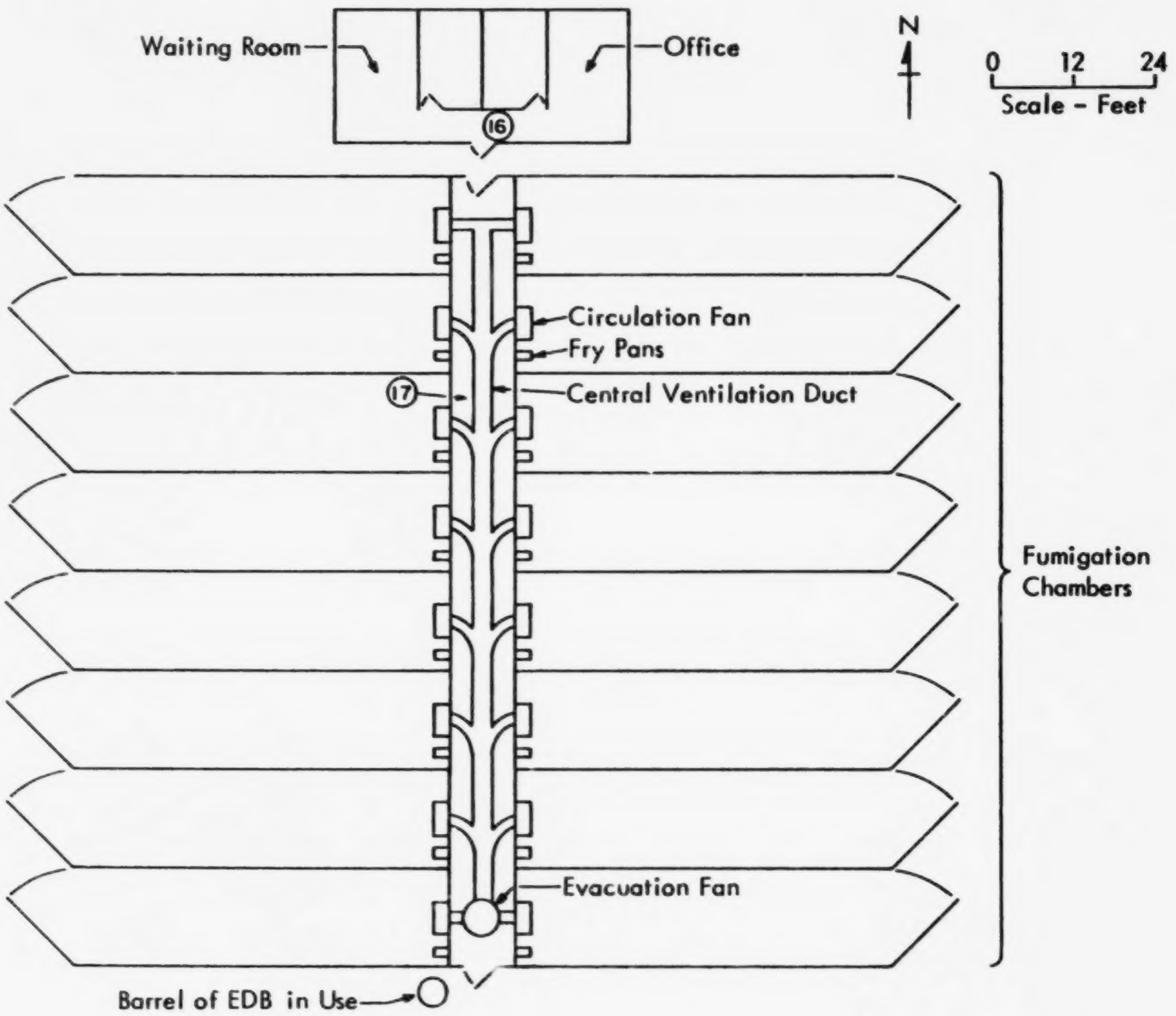

Waiting Room
Office
16
N
0
12
24
Scale - Feet
Circulation Fan
Fry Pans
17
Central Ventilation Duct
Fumigation Chambers
Evacuation Fan
Barrel of EDB in Use

Figure A-16. State of Florida-USDA Fumigation Center, Ft. Pierce, Florida.

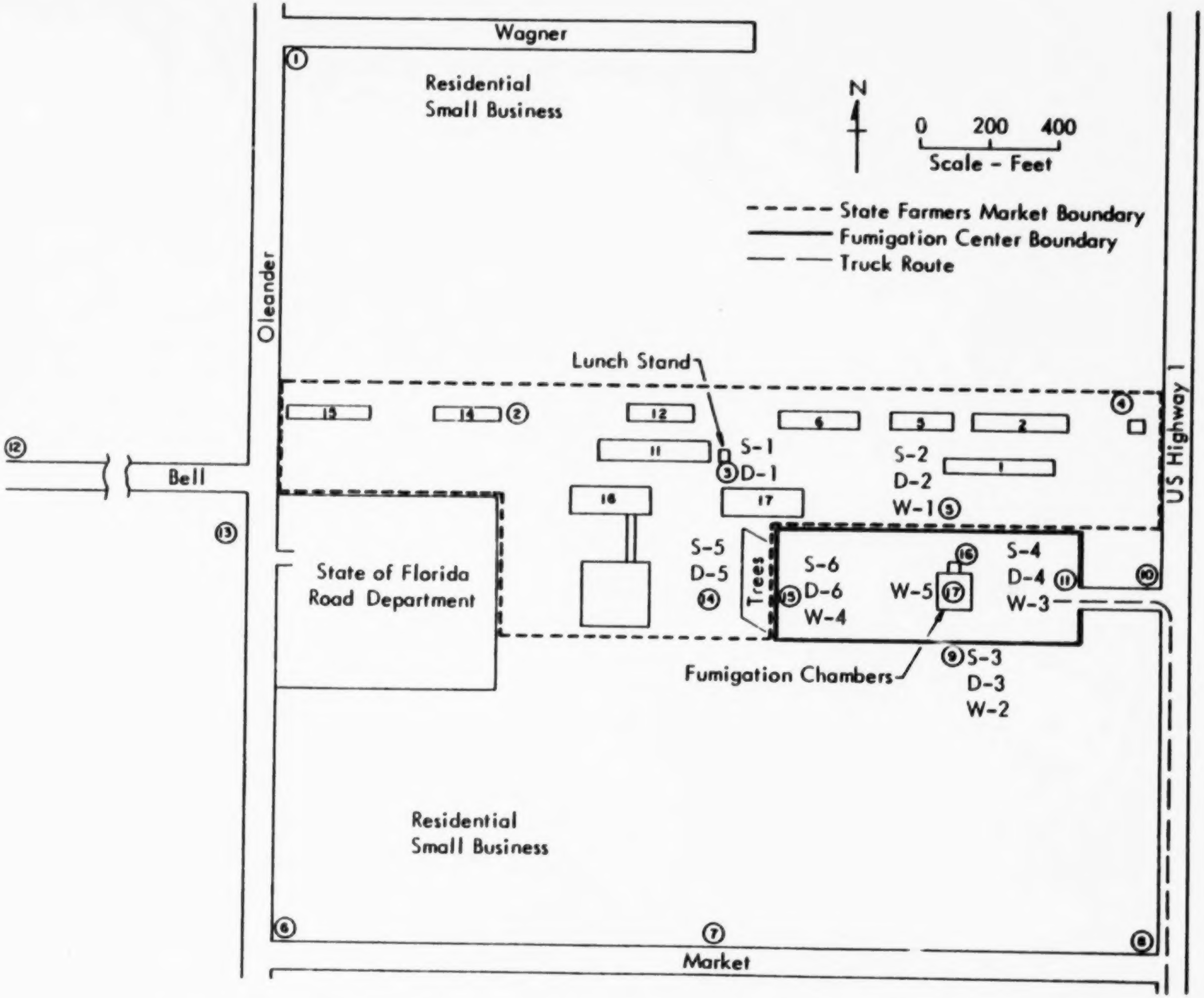

Wagner
①
Residential
Small Business
N
0 200 400
Scale - Feet
State Farmers Market Boundary
Fumigation Center Boundary
Truck Route
Oleander
Lunch Stand
④
15
14
②
12
6
3
2
⑫
11
S-1
③D-1
S-2
D-2
W-1⑤
1
Bell
16
17
US Highway 1
⑬
S-5
D-5
⑭
Trees
⑮
S-6
D-6
W-4
⑯
W-5
⑰
S-4
D-4
⑪
W-3
⑩
State of Florida
Road Department
Fumigation Chambers
⑨S-3
D-3
W-2
Residential
Small Business
⑥
⑦
⑧
Market

Figure A-17. Sampling locations at the Fumigation Center, Wahneta, Florida.

Table A-20. AIR SAMPLING DATA AT THE STATE OF FLORIDA-USDA FUMIGATION CENTER, FT. PIERCE, FLORIDA

Area	Sample No.	Exact location	Total sampling time (hr)	Sampling rate (ℓ/min)	Total sample vol. (ℓ)	Sampler height (ft)
Northwest transect, 1/2 mile	1	Wagner and Oleander	13.2	1.32	1,050	5.0
Northwest transect, 1/4 mile	2	1,400 ft West-northwest of fumigation center	13.2	1.23	970	5.0
Northwest transect, 1/8 mile	3	750 ft Northwest of fumigation center	13.0	1.41	1,099	5.0
Northeast transect, 1/4 mile	4	1,400 ft North-northeast of fumigation center	13.5	0.97	778	5.0
North transect, 0 mile	5	180 ft North of fumigation center	13.7	1.04	851	5.0
North transect, 0 mile	5a	180 ft North of fumigation center	3.8	1.41	324	5.0
North transect, 0 mile	5b	180 ft North of fumigation center	4.9	1.47	432	5.0
North transect, 0 mile	5c	180 ft North of fumigation center	2.85	1.40	239	5.0
North transect, 0 mile	5d	180 ft North of fumigation center	2.03	1.45	177	5.0
Southwest transect, 1/2 mile	6	Market and Oleander	13.3	1.23	979	5.0
Southwest transect, 1/4 mile	7	1,200 ft Southwest of fumigation center	13.3	0.98	781	5.0
Southeast transect, 1/4 mile	8	1,200 ft South-southeast of fumigation center	13.4	1.20	963	5.0
South transect, 0 mile	9	100 ft South of fumigation center	13.0	0.74	576	5.0
South transect, 0 mile	9a	100 ft South of fumigation center	3.1	1.41	262	5.0
South transect, 0 mile	9b	100 ft South of fumigation center	4.8	1.32	380	5.0
South transect, 0 mile	9c	100 ft South of fumigation center	2.75	1.28	212	5.0
South transect, 0 mile	9d	100 ft South of fumigation center	2.43	1.31	191	5.0
East transect, 1/8 mile	10	650 ft East of fumigation center	13.2	0.58	470	5.0
East transect, 0 mile	11	400 ft East of fumigation center	13.1	0.58	451	5.0
West transect, 1 mile	12	1 Mile west on Bell	13.2	1.13	891	5.0
West transect, 1/2 mile	13	Bell and Oleander	13.2	1.18	938	5.0
West transect, 1/8 mile	14	650 ft West of fumigation center	13.1	0.78	614	5.0
West transect, 0 mile	15	450 ft West of fumigation center	2.6	0.60	94	5.0
West transect, 0 mile	15a	450 ft West of fumigation center	2.9	0.64	111	5.0
West transect, 0 mile	15b	450 ft West of fumigation center	4.6	0.82	228	5.0
West transect, 0 mile	15c	450 ft West of fumigation center	2.9	0.83	145	5.0
West transect, 0 mile	15d	450 ft West of fumigation center	2.5	0.83	123	5.0

Table A-20 (concluded)

Area	Sample No.	Exact location	Total sampling time (hr)	Sampling rate (ℓ/min)	Total sample vol. (ℓ)	Sampler height (ft)
Office building	16	Entrance hall of office building adjacent to fumigation chambers	12.8	1.22	934	5.0
Office building	16a		2.8	1.10	185	5.0
Office building	16b		4.5	1.33	360	5.0
Office building	16c		3.7	1.29	222	5.0
Office building	16d		2.60	1.29	201	5.0
Corridor	17	Midpoint of corridor between two banks of fumigation chambers	12.8	1.28	981	5.0
Corridor	17a		3.0	1.37	244	5.0
Corridor	17b		4.5	1.27	340	5.0
Corridor	17c		2.8	1.30	221	5.0
Corridor	17d		2.5	1.28	189	5.0
Personnel sampler	18	Attached to personnel working in chambers, corridor, and office	4.0	0.83	199	5.0
Personnel sampler	19		3.3	0.99	198	5.0

Table A-21. FUMIGATION ACTIVITY AT THE FT. PIERCE FUMIGATION FACILITY, MAY 6, 1976

Fumigation No.	Fumigation time	Evacuation time	EDB Used (g)
1	1000-1200	1200-1300	1,900
2	1010-1210	1210-1310	1,900
3	1035-1235	1235-1335	1,900
4	1035-1235	1235-1335	1,900
5	1050-1250	1250-1350	1,900
6	1110-1310	1310-1410	1,900
7	1135-1335	1335-1435	1,900
8	1245-1445	1445-1545	1,900
9	1245-1445	1445-1545	1,900
10	1430-1630	1630-1730	1,900
11	1450-1650	1650-1750	1,900
12	1450-1650	1650-1750	1,900
13	1450-1650	1650-1750	1,900
14	1450-1650	1650-1750	1,900
15	1455-1655	1655-1755	1,900
16	1535-1735	1735-1835	1,900
17	1610-1810	1810-1910	1,900
18	1610-1810	1810-1910	1,900
19	1735-1935	1935-2035	1,900
20	1815-2015	2015-2115	1,900
21	1815-2015	2015-2115	1,900
22	1820-2020	2020-2120	1,900
23	1820-2020	2020-2120	1,900
24	1820-2020	2020-2120	1,900
25	1820-2020	2020-2120	1,900
26	1930-2130	2130-2230	1,900
27	1935-2135	2135-2235	1,900
28	2000-2200	2200-2300	1,900
29	2110-2310	2310-0010	1,900
30	2140-2340	2340-0040	1,900
31	2140-2340	2340-0040	1,900
32	2145-2345	2345-0045	1,900
33	2155-2355	2355-0055	1,900
34	2155-2355	2355-0055	1,900
		Total grams used	64,600

Soil Sampling

Soil samples were collected at the following air sampling stations.

S-1, Station 3
S-2, Station 5
S-3, Station 9
S-4, Station 11
S-5, Station 14
S-6, Station 15

Dustfall Sampling

Dustfall samples were collected at the following air sampling stations during the period that air samples were being collected.

D-1, Station 3
D-2, Station 5
D-3, Station 9
D-4, Station 11
D-5, Station 14
D-6, Station 15

Rainfall and Runoff Water Sampling

Rainfall collection equipment was placed at the facility boundaries by air sampling stations 5, 9, 11, and 15 from 1010 to 1800. Rain occurred in the area at approximately 1010 and was heavy until 1020, light until 1030, and then ceased for the remainder of the day. Water samples, W-1 through W-4, respectively, were collected at the four stations. A runoff water sample, W-5, was collected from the facility parking lot 100 ft west of the fumigation building at 1030.

Meteorological Conditions

The prevailing weather conditions during the sampling period are summarized in Table A-22.

Table A-22. WEATHER CONDITIONS DURING SAMPLING AT FT. PIERCE FUMIGATION CENTER, MAY 6, 1976

Time	Temp. (°C)	Wind Speed (mph)	Wind Direction	Precipitation
0800	24	12	E	None
0900	25	15	E	None
1000	27	13	ESE	Heavy shower
1100	27	15	ENE	None
1200	27	15	E	None
1300	27	12	E	None
1400	27	14	ESE	None
1500	27	12	ESE	None
1600	27	14	E	None
1700	26	11	E	None
1800	25	10	ESE	None
1900	24	14	ESE	None
2000	24	15	ESE	None
2100	24	12	ESE	None
2200	24	10	ESE	None
2300	24	11	ESE	None
2400	24	10	ESE	None

APPENDIX B

ANALYTICAL DATA

Table B-1. EDB CONCENTRATIONS IN AIR SAMPLES FROM CONTINENTAL OIL COMPANY, PONCA CITY, OKLAHOMA

Sampling station	Sampling time	Volume (ℓ)	Type of sample[a]	ng[b]	$\mu g/m^3$	ppb	$\mu g/m^3$[c]	ppb[c]
1	0612-0005	1,320	1st Charcoal	78	0.059	0.0077	0.088	0.011
2	0628-0011	1,342	1st Charcoal	84	0.063	0.0081	0.093	0.012
3	0636-0016	1,337	1st Charcoal	72	0.054	0.0070	0.080	0.010
4	0647-0022	1,418	1st Charcoal	61	0.043	0.0055	0.064	0.008
5	0655-0027	1,412	1st Charcoal	70	0.050	0.0064	0.074	0.0096
6	0709-0011	1,309	1st Charcoal	46	0.035	0.0046	0.052	0.007
7	0704-0015	1,458	1st Charcoal	51	0.035	0.0046	0.052	0.007
8	0714-0023	1,457	1st Charcoal	47	0.032	0.0042	0.048	0.006
9	0652-0027	1,516	1st Charcoal	51	0.034	0.0043	0.050	0.007
10	0714-0107	1,462	1st Charcoal	66	0.045	0.0059	0.067	0.009
11	0721-0102	1,307	1st Charcoal	65	0.050	0.0065	0.074	0.0096
12	0729-0057	1,253	1st Charcoal	57	0.045	0.0059	0.068	0.009
13	0740-0052	1,542	1st Charcoal	58	0.038	0.0049	0.056	0.007
14	0750-0037	819	1st Charcoal	36	0.044	0.0057	0.065	0.0085
15	0642-0048	1,456	1st Charcoal	61	0.042	0.0054	0.062	0.008
16	0635-0045	1,057	1st Charcoal	64	0.061	0.0081	0.090	0.012
17	0629-0041	1,076	1st Charcoal	64	0.059	0.0077	0.089	0.012
18	0619-0034	1,344	1st Charcoal	64	0.048	0.0062	0.071	0.009
19	0605-0058	1,005	1st Charcoal	52	0.052	0.0067	0.077	0.010
20	0613-0053	1,528	1st Charcoal	135	0.088	0.0114	0.131	0.017

---

[a] No EDB was found on any filters, back-up charcoal tubes or field blanks.

[b] Average of analysis on didecyl phthalate and Carbowax 20 M columns.

[c] Multiplied by 1.49 to account for 67% average recovery.

Table B-2. EDB CONCENTRATIONS IN AIR SAMPLES FROM MOBIL OIL COMPANY, PAULSBORO, NEW JERSEY

Sampling station	Sampling time	Volume (ℓ)	Type of sample[a]	ng[b]	µg/m^3	ppb	µg/m^3[c]	ppb[c]
1	0700-0003	1,242	1st Charcoal	105	0.085	0.0110	0.126	0.016
2	0710-0010	1,205	1st Charcoal	125	0.104	0.0135	0.155	0.020
3	0627-0016	1,348	1st Charcoal	70	0.052	0.0068	0.077	0.010
4	0637-0012	1,345	1st Charcoal	88	0.065	0.0085	0.097	0.013
5	0647-0008	1,353	1st Charcoal	94	0.069	0.0090	0.103	0.013
6	0656-0002	1,051	1st Charcoal	82	0.078	0.010	0.115	0.015
7	0635-0021	1,346	1st Charcoal	85	0.063	0.0082	0.094	0.012
8	0629-0019	1,377	1st Charcoal	186	0.135	0.018	0.201	0.026
9	0615-0030	1,120	1st Charcoal	66	0.059	0.0076	0.088	0.011
10	0644-0030	1,505	1st Charcoal	106	0.070	0.0092	0.105	0.014
11	0720-2356	1,045	1st Charcoal	85	0.081	0.0106	0.121	0.016
12	0710-2350	1,325	1st Charcoal	83	0.063	0.0081	0.093	0.012
13	0615-2355	1,385	1st Charcoal	175	0.126	0.0164	0.188	0.024

---

[a] No EDB was found on any filters, back-up charcoal tubes or field blanks.

[b] Average of analysis of didecyl phthalate and Carbowax 20 M columns.

[c] Multiplied by 1.49 to account for 67% average recovery.

Table B-3. EDB CONCENTRATIONS IN AIR SAMPLES FROM THE RETAIL GASOLINE SITE, PHOENIX, ARIZONA

Sampling station	Sampling time	Volume (ℓ)	Type of sample[a]	ng[b]	$\mu g/m^3$	ppb	$\mu g/m^3$[c]	ppb[c]
1	0636-0038	822	1st Charcoal	152	0.185	0.0241	0.276	0.036
2	0625-0041	1,092	1st Charcoal	194	0.178	0.0231	0.265	0.034
3	0618-0045	673	1st Charcoal	148	0.220	0.0286	0.328	0.043
4	0605-0034	766	1st Charcoal	220	0.287	0.0373	0.428	0.056
5	Lost	-	-	-	-	-	-	-
6	0627-2440	1,061	1st Charcoal	138	0.130	0.0169	0.194	0.025
7	0620-2435	934	1st Charcoal	225	0.241	0.0313	0.359	0.047
8	0612-2445	849	1st Charcoal	222	0.261	0.0340	0.390	0.051
9	0553-0038	1,055	1st Charcoal	163	0.155	0.0200	0.230	0.030
10	0545-0029	834	1st Charcoal	203	0.243	0.0313	0.363	0.047
11	0539-0018	1,068	1st Charcoal	263	0.246	0.0320	0.367	0.048
12	0532-0014	1,116	1st Charcoal	221	0.198	0.0257	0.295	0.038
13	0522-0010	987	1st Charcoal	333	0.337	0.0439	0.503	0.065
14	0603-2407	1,136	1st Charcoal	155	0.136	0.0177	0.203	0.026
15	0555-2414	885	1st Charcoal	173	0.195	0.0254	0.291	0.038
16	0545-2420	964	1st Charcoal	185	0.192	0.0249	0.286	0.037
17	0535-2425	1,164	1st Charcoal	181	0.155	0.0202	0.232	0.030
18	0525-2430	675	1st Charcoal	193	0.286	0.0371	0.426	0.055

---

a/ No EDB was found on any filters, back-up charcoal tubes or field blanks.
b/ Average of analysis of didecyl phthalate and Carbowax 20 M columns.
c/ Multiplied by 1.49 to account for 67% average recovery.

Table B-4. EDB CONCENTRATIONS IN AIR SAMPLES FROM THE RETAIL GASOLINE SITE, LOS ANGELES, CALIFORNIA

Sampling station	Sampling time	Volume (ℓ)	Type of sample[a]	ng[b]	µg/m^3	ppb	µg/m^3[c]	ppb[c]
1	0624-1925	1,147	1st Charcoal	69	0.060	0.0078	0.089	0.012
2	0615-1922	844	1st Charcoal	52	0.062	0.0080	0.092	0.012
3	0607-1918	889	1st Charcoal	53	0.060	0.0078	0.089	0.012
4	0600-1914	799	1st Charcoal	56	0.070	0.0091	0.104	0.014
5	0550-1930	736	1st Charcoal	91	0.124	0.0161	0.184	0.024
6	0614-1925	874	1st Charcoal	58	0.066	0.0086	0.099	0.013
7	0608-1929	923	1st Charcoal	61	0.066	0.0086	0.098	0.013
8	0601-1933	870	1st Charcoal	52	0.060	0.0078	0.089	0.012
9	0551-1917	866	1st Charcoal	93	0.107	0.0140	0.160	0.021
10	0637-1941	916	1st Charcoal	63	0.069	0.0089	0.102	0.013
11	0631-1937	924	1st Charcoal	54	0.058	0.0076	0.087	0.011
12	0650-1942	952	1st Charcoal	96	0.101	0.0131	0.150	0.020
13	0643-1937	705	1st Charcoal	45	0.064	0.0083	0.095	0.012
14	0636-1934	658	1st Charcoal	54	0.082	0.0106	0.122	0.016

---

[a] No EDB was found on any filters, back-up charcoal tubes or field blanks.

[b] Average of analysis on didecyl phthalate and Carbowax 20 M columns.

[c] Multiplied by 1.49 to account for 67% average recovery.

Table B-5. EDB CONCENTRATIONS IN AIR SAMPLES FROM THE RETAIL GASOLINE SITE, CAMDEN, NEW JERSEY

Sampling station	Sampling time	Volume (ℓ)	Type of sample[a]	ng[b]	$\mu g/m^3$	ppb	$\mu g/m^3$[c]	ppb[c]
1	0730-1907	693	1st Charcoal	223	0.322	0.0419	0.480	0.062
2	0649-1904	503	1st Charcoal	164	0.326	0.0424	0.486	0.063
3	0700-1900	796	1st Charcoal	204	0.256	0.0333	0.382	0.050

---

[a] No EDB was found on any filters, back-up charcoal tubes or field blanks.

[b] Average of analysis of didecyl phthalate and Carbowax 20 M columns.

[c] Multiplied by 1.49 to account for 67% average recovery.

Table B-6. EDB CONCENTRATIONS IN AIR SAMPLES FROM THE HIGHLY TRAFFICKED URBAN SITE, PHOENIX, ARIZONA

Sampling station	Sampling time	Volume (ℓ)	Type of sample[a]	ng[b]	$\mu g/m^3$	ppb	$\mu g/m^3$[c]	ppb[c]
1	0645-0020	726	1st Charcoal	198	0.273	0.0355	0.406	0.053
2	0635-0016	915	1st Charcoal	189	0.207	0.0269	0.308	0.040
3	0625-0013	849	1st Charcoal	201	0.237	0.0308	0.353	0.046
4	0615-0006	873	1st Charcoal	226	0.259	0.0337	0.386	0.050
5	0600-0002	958	1st Charcoal	214	0.223	0.0290	0.333	0.043
6	0655-2425	860	1st Charcoal	182	0.212	0.0275	0.315	0.041
7	0645-2420	820	1st Charcoal	197	0.240	0.0312	0.358	0.047
8	0635-2414	359	1st Charcoal	101	0.281	0.0366	0.419	0.054
9	0625-2409	933	1st Charcoal	203	0.218	0.0283	0.324	0.042
10	0610-2403	631	1st Charcoal	188	0.298	0.0387	0.444	0.058

---

[a] No EDB was found on any filters, back-up charcoal tubes or field blanks.

[b] Average of analysis of didecyl phthalate and Carbowax 20 M columns.

[c] Multiplied by 1.49 to account for 67% average recovery.

Table B-7. EDB CONCENTRATIONS IN AIR SAMPLES FROM THE HIGHLY TRAFFICKED URBAN SITE, LOS ANGELES, CALIFORNIA

Sampling station	Sampling time	Volume (ℓ)	Type of sample[a]	ng[b]	$\mu g/m^3$	ppb	$\mu g/m^3$[c]	ppb[c]
1	0619-0028	1,169	1st Charcoal	95	0.081	0.0106	0.121	0.016
2	0612-0020	1,140	1st Charcoal	93	0.082	0.0106	0.122	0.016
3	0604-0015	1,079	1st Charcoal	87	0.081	0.0106	0.122	0.016
4	0557-0011	1,204	1st Charcoal	105	0.087	0.0113	0.130	0.017
5	0551-0008	1,252	1st Charcoal	131	0.105	0.0136	0.156	0.020
6	0627-0033	1,403	1st Charcoal	103	0.073	0.0095	0.109	0.014
7	0619-0024	1,176	1st Charcoal	90	0.077	0.0099	0.114	0.015
8	0609-0017	1,028	1st Charcoal	85	0.083	0.0106	0.123	0.016
9	0556-0008	1,371	1st Charcoal	112	0.082	0.0106	0.122	0.016

---

[a] No EDB was found on any filters, back-up charcoal tubes or field blanks.

[b] Average of analysis on didecyl phthalate and Carbowax 20 M columns.

[c] Multiplied by 1.49 to account for 67% average recovery.

Table B-8. EDB CONCENTRATIONS IN AIR SAMPLES FROM THE SUBURBAN RESIDENTIAL SITE, KANSAS CITY, MISSOURI

Sampling station	Sampling time	Volume (ℓ)	Type of sample[a]	ng[b]	μg/m^3	ppb	μg/m^3[c]	ppb[c]
1	0610-2330	1,287	1st Charcoal	52	0.040	0.0053	0.060	0.008

---

a/ No EDB was found in the filters, back-up charcoal tube of field blanks.
b/ Average of analysis of didecyl phthalate and Carbowax 20 M columns.
c/ Multiplied by 1.49 to account for 67% average recovery.

Table B-9. EDB CONCENTRATIONS IN AIR SAMPLES FROM THE RURAL SITE, MARYVILLE, MISSOURI

Sampling station	Sampling time	Volume (ℓ)	Type of sample[a]	ng[b]	μg/m^3	ppb	μg/m^3[c]	ppb[c]
1	0630-0021	1,255	1st Charcoal	41.5	0.049	0.0064	0.073	0.009
2	0631-0010	1,405	1st Charcoal	43.5	0.046	0.0063	0.069	0.009

---

a/ No EDB was found on any filters, back-up charcoal tubes or field blanks.
b/ Based on analysis on didecyl phthalate column only.
c/ Multiplied by 1.49 to account for 67% average recovery.

Table B-10. EDB CONCENTRATIONS IN AIR SAMPLES FROM THE STATE OF FLORIDA–USDA FUMIGATION CENTER, WAHNETA, FLORIDA

Sampling station	Sampling time	Volume (ℓ)	Type of sample	ng[a]	µg/m^3[b]	ppb[b]	µg/m^3[c]	ppb[c]
1	0800-2102	925	1st Charcoal	92	0.099	0.0129	0.148	0.019
2	0750-2111	952	1st Charcoal	65	0.068	0.0089	0.102	0.013
3	0740-2117	1,024	1st Charcoal	72	0.070	0.0091	0.105	0.014
4	0830-2302	1,016	Filter	72				
			1st Charcoal	168	0.236	0.0307	0.352	0.046
4a	0915-1132	156	1st Charcoal	10[d]	0.064	0.0083	0.096	0.012
4b	1155-1417	53	1st Charcoal	117[d]	2.21	0.287	3.29	0.428
4c	1940-2332	67	1st Charcoal	54[d]	0.806	0.105	1.20	0.156
			Filter 4a-c	68				
5	0900-2158	910	1st Charcoal	16.2 µg				
			2nd Charcoal	1.7 µg	19.7	2.55	29.3	3.81
6	0840-2315	1,113	Filter	104				
			1st Charcoal	Sample lost	-	-	-	-
6a	0923-1142	55	1st Charcoal	616[d]	11.2	1.45	16.7	2.17
6b	1147-1405	150	1st Charcoal	8.70 µg[d]	58.0	7.54	86.4	11.2
6c	1948-2236	179	1st Charcoal	139[d]	0.777	0.101	1.16	0.150
			Filter 6a-c	67				
7	0750-2131	1,108	Filter 6a-c	117	0.106	0.0137	0.157	0.020
8	0805-2125	678	Filter 6a-c	71	0.105	0.0136	0.156	0.020
9	0815-2137	834	Filter 6a-c	52	0.062	0.0081	0.093	0.012
10	0830-2143	889	Filter 6a-c	86	0.097	0.0126	0.144	0.019
11	0840-2150	1,051	Filter 6a-c	85	0.081	0.0105	0.121	0.016
12	0810-2320	1,110	Filter	86				
			1st Charcoal	455	0.487	0.0633	0.726	0.094
12a	0915-1145	117	1st Charcoal	ND	-	-	-	-
12b	1145-1401	88	1st Charcoal	74[d]	0.841	0.109	1.25	0.163
12c	1950-2238	111	1st Charcoal	78[d]	0.703	0.0914	1.05	0.136
			Filter 12a-c	95				
13	0840-2213	750	Filter 12a-c	275	0.367	0.0477	0.546	0.071
14	0850-2200	581	Filter 12a-c	800	1.38	0.179	2.05	0.267
15	0835-2308	895	Filter	87				
			1st Charcoal	11.4 µg	12.8	1.67	19.1	2.49
15a	0923-1134	159	1st Charcoal	15[d]	0.094	0.0122	0.141	0.018
15b	1135-1408	184	1st Charcoal	43[d]	0.234	0.0304	0.348	0.045
15c	1945-2234	246	1st Charcoal	4.83 µg[d]	19.6	2.55	29.2	3.80
			Filter 15a-c	79				
16	0855-2255	1,105	Filter	629				
			1st Charcoal	2.30 mg				
			2nd Charcoal	130	2,080	271	3,100	403
16a	0935-1141	192	1st Charcoal	126 µg[d]	656	85.3	978	127
16b	1141-1416	232	1st Charcoal	202 µg[d]	871	113	1,300	169
16c	1940-2229	176	1st Charcoal	47.9 µg[d]	272	35.4	405	52.7
16c			Filter 16a-c	1.12 µg				
17	0850-2246	1,102	Filter	134				
			1st Charcoal	278 µg	252	32.8	376	48.9
17a	0930-1143	178	1st Charcoal	19.7 µg[d]	111	14.4	165	21.4
17b	1143-1414	213	1st Charcoal	36.7 µg[d]	172	22.4	257	33.4
17c	1942-2227	212	1st Charcoal	118 µg[d]	557	72.4	829	108
			Filter 17a-c	181				

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[a] Average of analysis on didecyl phthalate and Carbowax 20 M columns.

[b] Concentration based on nanograms found on filter and charcoal except where noted. No EDB was found on the field blanks.

[c] Multiplied by 1.49 to account for 67% average recovery.

[d] Concentration based on nanograms found on charcoal only.

Table B-11. EDB CONCENTRATIONS IN AIR SAMPLES FROM THE STATE OF FLORIDA-USDA FUMIGATION CENTER, FT. PIERCE, FLORIDA

Sampling station	Sampling time	Volume (ℓ)	Type of sample	ng[a]	µg/m^3[b]	ppb[b]	µg/m^3[c]	ppb[c]
1	0912-2222	1,050	Filter	8				
			1st Charcoal	7.4 µg	7.05	0.917	10.5	1.37
2	0918-2227	970	Filter	16.3				
			1st Charcoal	11.2 µg	11.6	1.50	17.2	2.24
3	0930-2229	1,099	Filter	8				
			1st Charcoal	63.0 µg	57.3	7.46	85.4	11.1
4	0833-2200	788	1st Charcoal	99	0.127	0.0168	0.190	0.025
5	0830-2210	851	Filter	32				
			1st Charcoal	9.58 µg	11.3	1.47	16.8	2.19
5a	0830-1220	324	1st Charcoal	132[d]	0.407	0.0530	0.607	0.079
5b	1223-1717	432	1st Charcoal	1.50 µg[d]	3.47	0.451	5.17	0.673
5c	1717-2008	239	1st Charcoal	452[d]	1.89	0.246	2.82	0.366
5d	2008-2210	177	1st Charcoal	11.4 µg[d]	64.4	8.37	96.0	12.5
			Filter 5a-d	29				
6	0853-2211	979	Filter	8				
			1st Charcoal	52	0.061	0.0080	0.091	0.012
7	0848-2208	781	Filter	8				
			1st Charcoal	286	0.376	0.0489	0.561	0.073
8	0841-2204	963	Filter	12				
			1st Charcoal	1.33 µg	1.39	0.181	2.08	0.270
9	0920-2220	576	Filter	26				
			1st Charcoal	124	0.260	0.0339	0.388	0.050
9a	0920-1225	262	1st Charcoal	35[d]	0.134	0.0174	0.199	0.026
9b	1226-1707	380	1st Charcoal	40[d]	0.105	0.0137	0.157	0.020
9c	1707-1952	212	1st Charcoal	55[d]	0.259	0.0338	0.388	0.050
9d	1952-2220	191	1st Charcoal	20[d]	0.105	0.0137	0.157	0.020
			Filter 9a-d	35				
10	0907-2220	470	Filter	24				
			1st Charcoal	348	0.791	0.103	1.18	0.153
11	0914-2215	451	Filter	32				
			1st Charcoal	411	0.982	0.127	1.46	0.190
12	0905-2217	891	Filter	24				
			1st Charcoal	156	0.202	0.0263	0.301	0.039
13	0900-2214	938	1st Charcoal	150	0.160	0.0208	0.238	0.031
14	0925-2233	614	Filter	8				
			1st Charcoal	342	1.38	0.180	2.06	0.268
15	0937-1232	94	Filter	32				
			1st Charcoal	361	3.84	0.499	5.72	0.744
15a	0937-1230	111	1st Charcoal	126[d]	1.14	0.148	1.69	0.220
15b	1231-1708	228	1st Charcoal	124[d]	0.544	0.0707	0.810	0.105
15c	1708-1957	145	1st Charcoal	53[d]	0.366	0.0475	0.545	0.071
15d	1957-2225	123	1st Charcoal	20[d]	0.162	0.021	0.242	0.031
			Filter 15a-d	28				

Table B-11 (concluded)

Sampling station	Sampling time	Volume (l)	Type of sample	ng[a]	µg/m³[b]	ppb[b]	µg/m³[c]	ppb[c]
16	0952-2240	934	Filter	43				
			1st Charcoal	326 µg	349	45.4	520	67.6
16a	0952-1240	185	1st Charcoal	83 µg[d]	449	58.3	668	86.9
16b	1241-1712	360	1st Charcoal	96 µg[d]	267	34.7	397	51.7
16c	1712-2004	222	1st Charcoal	39 µg[d]	176	22.8	262	34.0
16d	2004-2240	261	1st Charcoal	72 µg[d]	276	35.8	411	53.4
			Filter 16a-d	43				
17	0945-2230	981	Filter	110				
			1st Charcoal	1.52 mg				
			2nd Charcoal	1.25 µg	1,549	201	2,308	300
17a	0945-1243	244	1st Charcoal	617 µg[d]	2,529	328.7	3,768	490
17b	1244-1712	340	1st Charcoal	669 µg[d]	1,968	255.8	2,932	381
17c	1712-2002	221	1st Charcoal	311 µg[d]	1,407	182.9	2,097	273
17d	2002-2231	189	1st Charcoal	116 µg[d]	613.8	79.8	914.5	119
			Filter 17a-d	84				
18	1405-1806	199	1st Charcoal	776 µg				
			2nd Charcoal	16	3,900	507	5,810	755
19	1810-2130	198	1st Charcoal	913 µg				
			2nd Charcoal	8 µg	4,650	605	6,930	901

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[a] Average of analysis of didecyl phthalate and Carbowax 20 M columns.

[b] Concentration based on nanograms found on filter and charcoal except where noted. No EDB was found on the field blanks.

[c] Multiplied by 1.49 to account for 67% average recovery.

[d] Concentration based on nanograms found on charcoal only.

APPENDIX C

METHOD DEVELOPMENT FOR SAMPLING AND ANALYSIS

LITERATURE

The published literature on the sampling and analysis of EDB in air has been largely related to its use as a fumigant. Interstitial air concentrations in closed bins or silos have been determined by direct analysis of gas samples using flame ionization gas chromatography.[2] The limit of detection by this technique was 2 mg/m^3 or 240 ppb (v/v). In a preliminary study by MRI of air levels of EDB, a trap of Tenax®-GC cooled with dry ice was used.[3] In an unpublished report, charcoal has been used to trap EDB.[4]

No reports of EDB being present in surface waters were found in the literature. Several procedures for multiresidue analyses of EDB on grains were expected to be satisfactory for analyzing water. In one procedure[5] grains coated with EDB were added to water, toluene was added, and the EDB was quantitatively removed by steam distillation. Alternately, EDB can be removed by a nitrogen sparge of a boiling solution.[6] In this procedure water present in the gas stream was removed by a drying trap of Chromosorb W. The EDB was then trapped in isooctane held at -80°C.

AIR SAMPLING AND RECOVERY STUDIES

The prior sampling train[3] used for air samples consisted of a drying tube followed by a 14-mm O.D. by 12-mm I.D. by 15-cm glass tube packed with Tenax®-GC at dry ice temperature. This system had a disadvantage in that water vapor would freeze in the tubes and restrict flow. Frequent monitoring of the station was required. In humid weather, both drying tubes and Tenax tubes were frequently changed. While this was feasible with a very limited number of stations, it would be exceedingly difficult for the present program having up to 20 stations several miles apart. It was felt that a sampling system had to be developed that was less restricted by weather conditions and would require minimal supervision. Charcoal[4] has been reported to be effective in trapping EDB. Desorption was effected by carbon disulfide extraction, followed by analysis by flame ionization gas chromatography.

For analysis of air for EDB in the parts per million range, such as exists around the manufacturing sites, the flame ionization detector has adequate sensitivity. In urban areas, however, the ambient EDB levels were much smaller and the more sensitive electron-capture detector was required. Use of the electron-capture detector, however, precluded the use of carbon disulfide as the desorbing solvent. In our evaluation of charcoal as a trapping medium, we investigated the following: capacity of the trap, choice of solvent, activity of the charcoal, optimum method of desorption, and recovery of EDB at various levels.

CAPACITY

A glass tube 8-mm O.D., 6-mm I.D., and 16-cm long was packed with approximately 2 g Fisher 6 to 14 mesh charcoal. The charcoal had been activated and partially deactivated by a procedure described below. After adding 54.0 µg of EDB to the inlet end, helium was passed through the tube at 0.75 liters/min for 7 hr. The helium was directed through a hexane trap cooled with crushed dry ice. This has been shown previously to trap EDB quantitatively.[3] Analysis of the hexane solution showed that no EDB had passed through the charcoal trap.

SOLVENT

Several solvents were screened to determine: (a) if they were compatible with the electron-capture detector, and (b) the ability to remove EDB from charcoal. Hexane and benzene were acceptable while carbon disulfide gave a broad peak that would interfere with EDB detection. Known quantities of EDB were then added to charcoal and extracted with hexane or benzene. Benzene was found to be more effective than hexane in removing the EDB. For the remaining studies, only benzene was used.

ACTIVITY

Before use, the Fisher charcoal was treated by heating to 400°C for 1 hr under a stream of nitrogen. When EDB was added directly to this charcoal and then desorbed with benzene, the recoveries were consistent but lower than desired, e.g., 48, 52, 50, and 31%. Removal of the EDB using a Soxhlet extractor gave similar results: 49, 63, 51, and 45%. Low recovery was observed both for 50- and 500-ng samples of EDB. These results suggest that a fraction of the EDB is irreversibly adsorbed by highly active sites on the charcoal. A partially deactivated charcoal was prepared in the following manner. Benzene was first added to wet the activated charcoal. Excess benzene was removed after 1/2 hr by decantation. The moist charcoal was placed in a tube and further dried by a stream of nitrogen. It was then dried at 110°C for 1/2 hr. Using 2 g of charcoal prepared in this manner and extraction with benzene, the average percent recovery for 11 samples was 67% with a standard deviation of 10%. The sample size ranged from 50 to 5,000 ng.

EXTRACTION TECHNIQUE

Three extraction techniques were tested to desorb EDB from treated charcoals: (a) sequential extraction by 20, 20, and 10 ml of benzene; (b) sequential extraction by 10, 10, and 5 ml of benzene; and (c) Soxhlet extraction using 50 ml of benzene. Initially, (a) and (c) were compared using 500 ng of EDB. Average recoveries from four analyses were 73 and 50%, respectively. Lower recoveries using the Soxhlet equipment had been seen previously. It was then shown that (b) gave comparable results to (a). Since (b) gives final solutions of a higher concentration than (a), procedure (b) will be used in the final protocol.

EDB RECOVERY

Using the treated charcoal and the extraction procedure developed above, the recovery of various concentrations of EDB was determined. The overall average recovery of duplicate samples of 50, 500, and 5,000 ng of EDB was 65%. Figure C-1 shows the recoveries and ranges of the results.

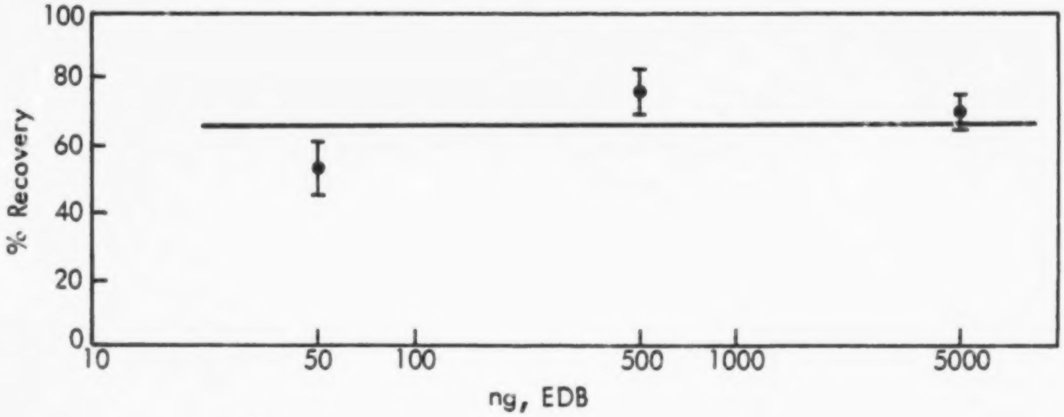

Figure C-1. Recovery of EDB from charcoal.

PUMP AND SAMPLING STATION

The number of sampling stations required and the large distance between them precludes the use of 110 V line power or portable electrical generators. The portable electrical generators are further excluded due to the fact that they are powered by gasoline engines running on leaded, and therefore EDB-containing, gasoline. It was concluded that the air sampling pumps must be battery powered. It was considered desirable that the pump-battery sampling station be as small and light as possible with proven reliability. A miniature pump powered by 18 to 26 V DC was obtained from Brailsford and Company, Inc., Milton Point, Rye, New York 10580. The batteries could be either the conventional alkali lantern type or the rechargeable Ni-Cads. Ni-Cad batteries would only last for 8 to 10 hr in the field before they needed to be replaced and recharged. It was felt that the risk of an unattended pump stopping suddenly after 8 to 10 hr plus the need to recharge a large number of batteries were undesirable features. Therefore, an evaluation of the 12 V lantern batteries was conducted. Two 12-V batteries were connected in series to power the pump. A sampling train of two charcoal traps plus a Millipore filter was attached to the pump. After some initial experimentation, a test was run at 38°F for 24.5 hr using two 12-V batteries in series. Flow dropped from 1.02 to 0.96 liters/min or 8.8%, and voltage dropped from 24.5 to 19 V. The test was repeated using two 12-V batteries in series and one 12-V plus two 6-V batteries in series. The two 24-V battery systems were then wired in parallel to power the pump. The pump was run first for 20 hr at ambient temperature. Flow changed from 1.05 to 1.02 liters/min or 3%, while voltage dropped from 24.8 to 22 V. The test was repeated at -11°F using the same set of batteries. Flow dropped from 1.02 to 0.95 liters/min or 7% over 24 hr. Voltage changed from 21 to 17 V. It was concluded that the pump powered by two 24-V batteries in parallel was reliable and had a sufficiently constant flow rate.

The five batteries and the pump were attached to a prewired phenolic board which was then enclosed in a cardboard-polystyrene shipping box obtained from Polyfoam Packers Corporation, Chicago, Illinois. A mock-up of the sampling station with the adopted sampling train is shown in Figure C-2. In field operation, a metal rod was driven into the ground to which the box and the sampling train were attached.

WATER SAMPLING AND RECOVERY STUDIES

All water sampling was expected to be done by the "grab" technique. The reported technique of isolating EDB from water by steam distillation was judged as too complicated and time-consuming. A simpler and faster technique was required. It was determined that water samples containing EDB could be quantitatively extracted by hexane using two extractions at a V_{aq}/V_{org} ratio of 20:1. Five-hundred milliliters of water containing 5 ppb EDB was subjected to sequential extractions; recoveries of 82 and 20% were obtained, yielding a total recovery of 102%. If necessary, the extracts can be reduced in volume using a Kuderna-Danish evaporator. Two 500-ml water samples containing 0.1 ppb EDB were extracted with two 25-ml portions of hexane. The volume of the hexane was reduced to 5.0 ml by the evaporator. Recovery was 47 and 52%. Attempts to reduce the volume below 5 ml by a slow N_2 stream led to excessive loss of EDB.

Rainfall and dustfall samples are also water samples and can be treated similarly.

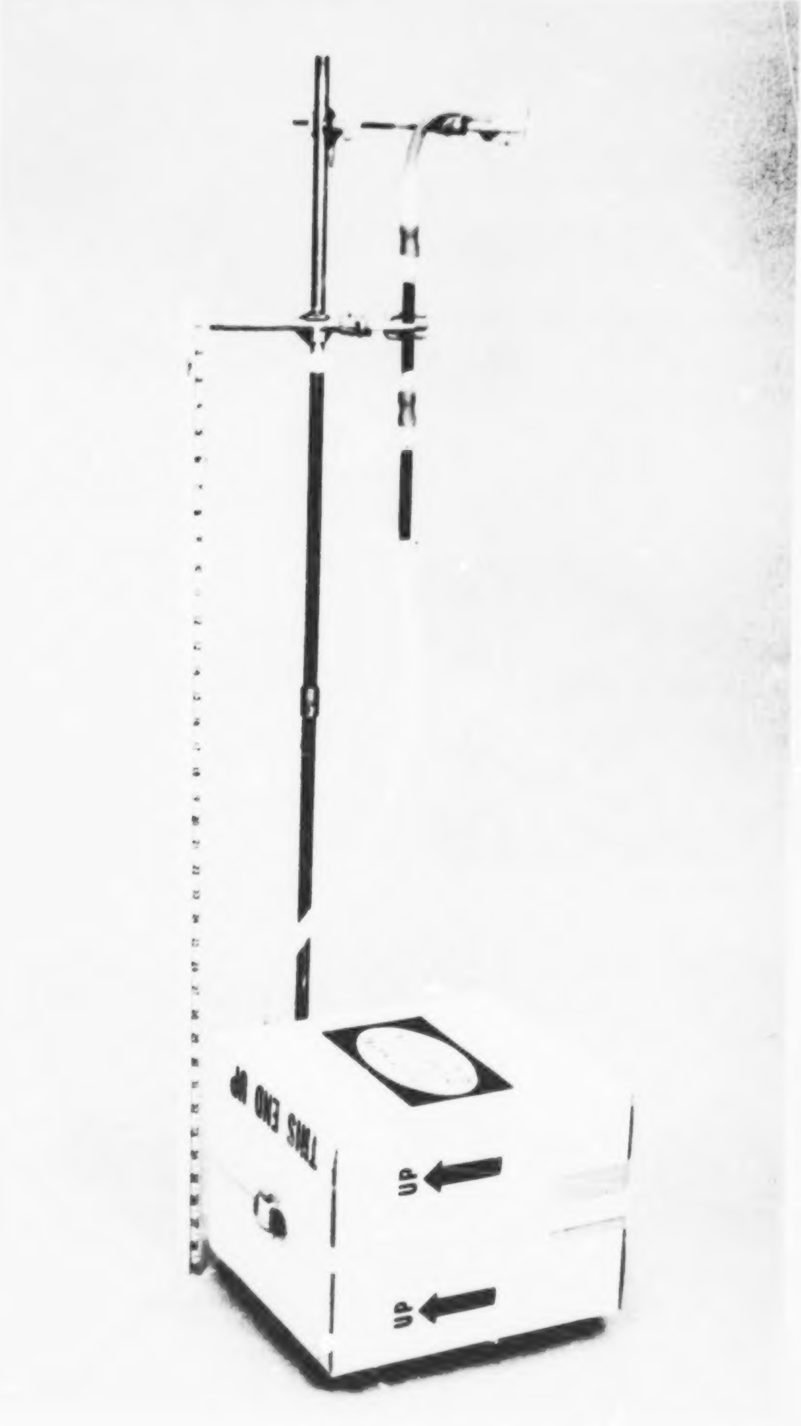
THIS END UP
UP
UP

Figure C-2. Sampling station.

GAS CHROMATOGRAPHIC ANALYSIS

The following columns and conditions were developed for the analysis of EDB in the sample extracts.

First Column: 10-ft by 1/8-in. stainless steel with 5% didecyl phthalate on 80/100 mesh Chromosorb W, AW, DMCS

Column Temperature: 110°C
Injector Temperature: 200°C
Detector Temperature: 250°C
Nitrogen Flow Rate: 28 ml/min

Second Column: 6-ft by 1/8-in. stainless steel with 5% Carbowax 20 M on 80/90 Anakrom

Column Temperature: 115°C
Injector Temperature: 205°C
Detector Temperature: 210°C
Nitrogen Flow Rate: 32 ml/min

Third Column: 12-ft by 1/8-in. stainless steel with 3% OV-225 on 100/120 Supelcoport

Column Temperature: 85°C
Injector Temperature: 180°C
Detector Temperature: 250°C
Nitrogen Flow Rate: 25 ml/min

A series of halogenated hydrocarbons were tested to determine if they would interfere with EDB analysis. Standards prepared in benzene were analyzed using the gas chromatographic conditions optimized for EDB analysis. The results are listed in Table C-1 as Relative Retention Times in comparison to EDB. None of the common chloro- or bromo- compounds interfere.

Table C-1. RELATIVE RETENTION TIMES

	Columns		
	Didecyl phthalate	Carbowax 20 M	OV-225
CH_3CCl_3	0.38	0.21	-
CCl_4	0.38	0.45	-
$CHCl{=}CCl_2$	0.48	0.31	0.52
CH_2Cl-CH_2Cl	0.52	0.45	-
$Cl_2C{=}CCl_2$	0.59	0.40	0.59
$CHBrCl_2$	0.68	0.62	0.66
$CH_2Cl-CHCl_2$	0.92	0.93	0.85
CH_2Br-CH_2Br	1.00	1.00	1.00
$CHBr_2Cl$	1.10	1.13	0.92

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